MARSHALLS

A-Test Radiation Warni

By Mike Feinsilber

WASHINGTON (AP) — The safety chief at the first post-war atomic bomb test warned in 1946 that the health of 42,000 American servicemen could be jeopardized by radiation fallout, according to a report prepared for a congressional hearing today. It said he was ignored.

Once-secret memos on the Bikini Atoll tests showed that another safety expert, identified only as "Capt. Lyon of the Radiological Safety Section," complained in vain about the disdain of ship commanders "for the unseen hazard" of radiation.

The fallout jeopardized sailors who slept on the decks of contaminated ships "with nothing more than shorts on," the memos said.

Today's report was based on letters and memos written or collected by the late Army Col. Stafford Warren, who was radiological safety chief during the Manhattan Project that developed the atomic bomb and held the same job during the first two post-war atomic explosions, Operation Crossroads.

In one of those tests, a 6,000-foot high column of radioactive water sprayed U.S. Navy ships and their crews.

The tests were conducted on Bikini Atoll in the South Pacific during July 1946 and were witnessed by about 40,000 U.S. servicemen and 2,000 civilian contractors.

WARREN'S declassified memos were found a few months ago among his papers in the library of the University of California at Los Angeles.

The report on his papers was prepared for a hearing of the House Veterans Affairs investigations subcommittee.

The papers were analyzed by two physicists, Arjun Makhijani and David Albright, for the International Radiation Research and Training Institute on behalf of the National Association of Atomic Veterans.

Lt. Gen. Harry A. Griffith, director of the Defense Nuclear Agency, told the subcommittee today he had been unaware of the memos and reports on the Bikini atomic tests and promised to study them.

Griffith testified, however, that the "overwhelming majority" of the participants in all of the nation's atmospheric tests received radiation at levels of less than 5 rem, a unit of radiation dose equivalancy.

He said this was a level that is still accepted as safe.

Griffith said that of all the Americans who took part in the tests 37,000 could be expected to die of cancers from natural causes while statistically only 11 could be expected to die of cancers caused by exposure during the tests.

DR. DAVID Auton, a Defense Nuclear Agency doctor said under questioning that protective measures for servicemen in the early tests were different from those which were taken later, when science knew far more about the hazards of atomic radiation.

ng Ignored, Report Says

That reply prompted Rep. Don Sundquist, R-Tenn., to tell Auton, "I find that statement ludicrous, Dr. Auton."

The veterans' association says a large number of the 250,000 American participants in 236 open-air atomic tests in Nevada and the Pacific, conducted between 1946 and 1962, are suffering from cancer. It is asking the government to give them medical treatment and compensation.

But the Pentagon's Defense Nuclear Agency says radiation exposures in the tests "generally were within established radiation exposure limits" and found no reason to believe that the health of participants was damaged.

THE REPORT on the Warren papers concluded that Operation Crossroads "was conducted in a manner which was grossly negligent regarding radiological safety for the 42,000 people who witnessed it . . . A cavalier attitude toward safety prevailed."

It said the million-ton column of water, spray and steam from the underwater atomic test fell on Bikini lagoon and the target ships, "irrevocably contaminating almost all of them with the products of atomic fission and with plutonium."

Warren noted in a memo that "contamination of personnel clothing, hands and even food can be demonstrated readily in every ship . . . in increasing amounts day by day."

The report said contamination was so widespread that a number of Navy ships were temporarily taken out of duty. It said the resulting shortage of ships in the Pacific was so severe that the Navy arbitrarily declared several "hot" ships to be "decontaminated."

It also said that "hot" ships were brought into San Francisco and other ports for experiments and decontamination. Most could not be decontaminated and ultimately were sunk, it said.

MAKHIJANI and Albright wrote that the problem of radiation was so severe that Gen. Leslie Groves, the military commander of the Manhattan Project, was 'very much afraid" that participants in the Bikini tests would sue the government for damages.

The National Association of Atomic Veterans said that many of the children and grandchildren of its members suffer from genetic defects and that the veterans of the tests are experiencing health difficulties.

"Although the evidence is still inconclusive, recent medical studies have suggested a significant link between such diseases as leukemia and other forms of cancer, neuro-muscular disorders, internal disorders and cardiovascular disease in atomic veterans and their offspring and their exposure to ionizing radiation," the association said.

A bill has been introduced in Congress to conduct a scientific study comparing the health of veterans of the tests with other men their age. But the Veterans Administration has testified against conducting such a study.

The Honolulu Advertiser Thursday, April 7, 1983 A-13

From Marshall Islands

'Independence' proposal empty

By Floyd K. Takeuchi
Advertiser Editorial Writer

If there is a Marshallese equivalent to chutzpa, the Yiddish word meaning gall or brazenness, it certainly applies to the proposed "Mutual Security Agreement" that the government of President Amata Kauba recently sent to Washington.

The document is intended to replace the Compact of Free Association, which was 13 years in the making. But the MSA's future is uncertain. Yesterday, Richard Teare of the U.S. Office of Micronesian Status Negotiations said in a telephone interview from Washington that the agreement "will be a footnote to history." Teare reiterated the long-standing American position that the compact is the better choice.

Last May, U.S. Ambassador Fred Zeder and Kabua approved the compact at Waikiki's Prince Kuhio Hotel. But it ran into heavy flak almost from the moment the ink was dry.

TWO GROUPS opposed the compact. One, the traditional landowners of Kwajalein, insisted on higher rent payments by the U.S. for use of the atoll as a missile testing range. A four-month-old "sail-in" ended last October when

President Amata Kabua

Washington agreed to top the annual $9 million lease payments with $12.5 million in supplemental aid and fewer shots into the lagoon, the world's largest.

The other faction is made up of those Marshallese who were, or may have been, affected by America's 12 years of nuclear weapons testing there. The group includes those from Bikini and Enewetak atolls, and the residents of Rongelap and Utirik who were dusted by fallout from a 1954 hydrogen bomb blast. In recent

asia-pacific focus

years, other islanders in the Northern Marshalls have begun to worry that they may also have been affected.

What worried them was a compact provision which would have ended their access to U.S. courts to press for claims. The Bikinians have a $450 million suit, and the Enewetakese a $500 million one, already in the courts.

Continued opposition by the "nuclear islanders" would likely have scuttled the free association agreement in the required plebiscite.

NOW, THE government in Majuro, capital of the self-proclaimed republic (it still is under American suzerainty), apparently wants to scuttle the compact in favor of its Mutual Security Agreement. Unlike the large and complicated compact, the MSA is only all of 33 paragraphs long.

Among the more significant aspects of the document are:

- While calling for full independence "without any conditions," the agreement lasts only for 15 years, the same time frame as the free association compact. The usual process of decolonization results in independence, pure and simple.
- Again, as in the compact, the United States is responsible for defense and security, and maintains the right to deny access to the republic to any third power for military purposes. Strategic denial is the primary American interest in the Trust Territory. American forces are also allowed to maintain nuclear weapons in the Marshalls.
- Despite a so-called independent status, those who may have been affected by the nuclear testing retain the right to sue Washington in American federal courts. In addition, the Marshalls government can sue the United States for failure to live up to the agreement in the U.S. Court of Claims.
- And the Marshalls wants $50 million a year from America for 15 years, in addition to $15 million annually for defense rights. Over the length of the agreement, that comes out to $975 million. That for a "country" of some 34,000 people. The free association compact, in comparison, calls for about $490 million over 15 years, not including access to some federal programs. And the compact requires that at least 40 percent of most of the grant go for capital development. Such a provision is conspicously absent in the new agreement.

In essence, then, President Kabua appears to be calling for free association under the guise of independence, and without the fiscal safegyards wisely insisted upon by Washington.

WORD FROM Washington is that there is movement toward resolving the differences between the United States and the Marshalls, though a few more weeks probably will pass before any resolution is announced.

If so, the proposed Mutual Security Agreement may indeed go down in history as yet another bargaining ploy.

National Museum of Natural History · Smithsonian Institution
WASHINGTON, D.C. 20560 · TEL. 202-

8 March 1983

Dr. George H. Balazs
Hawaii Institute of Marine Biology
University of Hawaii at Manoa
P.O. Box 1346, Coconut Island
Kaneohe, Hawaii 96744

Dear Dr. Balazs:

In reply to your letter of 18 February, as to whether the figure of 300 turtles that came ashore on Bikar Atoll could have been a misprint for 30, I can say positively that the figure 300 is what was intended. The figure in my notebook is 596 tracks plus six more observed visits. Counting two tracks per visit would give "over 300" visits. Of course some turtles may have come and gone more than once. I do not know what Pritchard may have meant by "numbers given in earlier parts of the paper" but doubtless it refers to figures for other atolls. The 300 is a firm figure if number of tracks divided by 2 is a reliable method of estimation.

I wish you good luck in your coming visit to the Marshalls. I hope the Bikar turtle population has not been depleted by poachers. I have noted a strong inverse correlation between turtles and people on islands.

I may have some close-up photos, but will have to search for them. Will let you know.

Very sincerely,

Ray Fosberg

F.R.Fosberg

February 18, 1983

Dr. F. R. Fosberg
Atoll Research Bulletin
Smithsonian Institution
Washington, D. C. 20560

Dear Dr. Fosberg:

I am writing to ask if you can provide me with some clarification on a paper you published in 1969 entitled "Observations on the green turtle in the Marshall Islands" (Atoll Research Bulletin No. 135). On page 12 it is stated that "...over 300..." female green turtles visited Bikar Atoll in the 7 nights of August 5-12, 1952. In a conference paper recently published by Peter Pritchard, the statement is made on page 270 "...it is possible that the "over 300" turtles is a misprint for "over 30". Copies of these sections have been enclosed for your examination. I would be interested to learn if the "300" number is actually a misprint. Any insight that you can provide on this subject will be greatly appreciated.

There is a good possibility that I will be visiting Bikar and other turtle nesting sites in the Marshalls this coming summer. Very few reports about turtles have been made from this area since 1971. However, it is highly likely that foreign boats have been making regular visits on an illegal basis. Apparently there is even a wrecked fishing boat sitting on the reef. In any event, I hope to gather reliable up-to-date information during this coming year.

I look forward to hearing from you when your time permits.

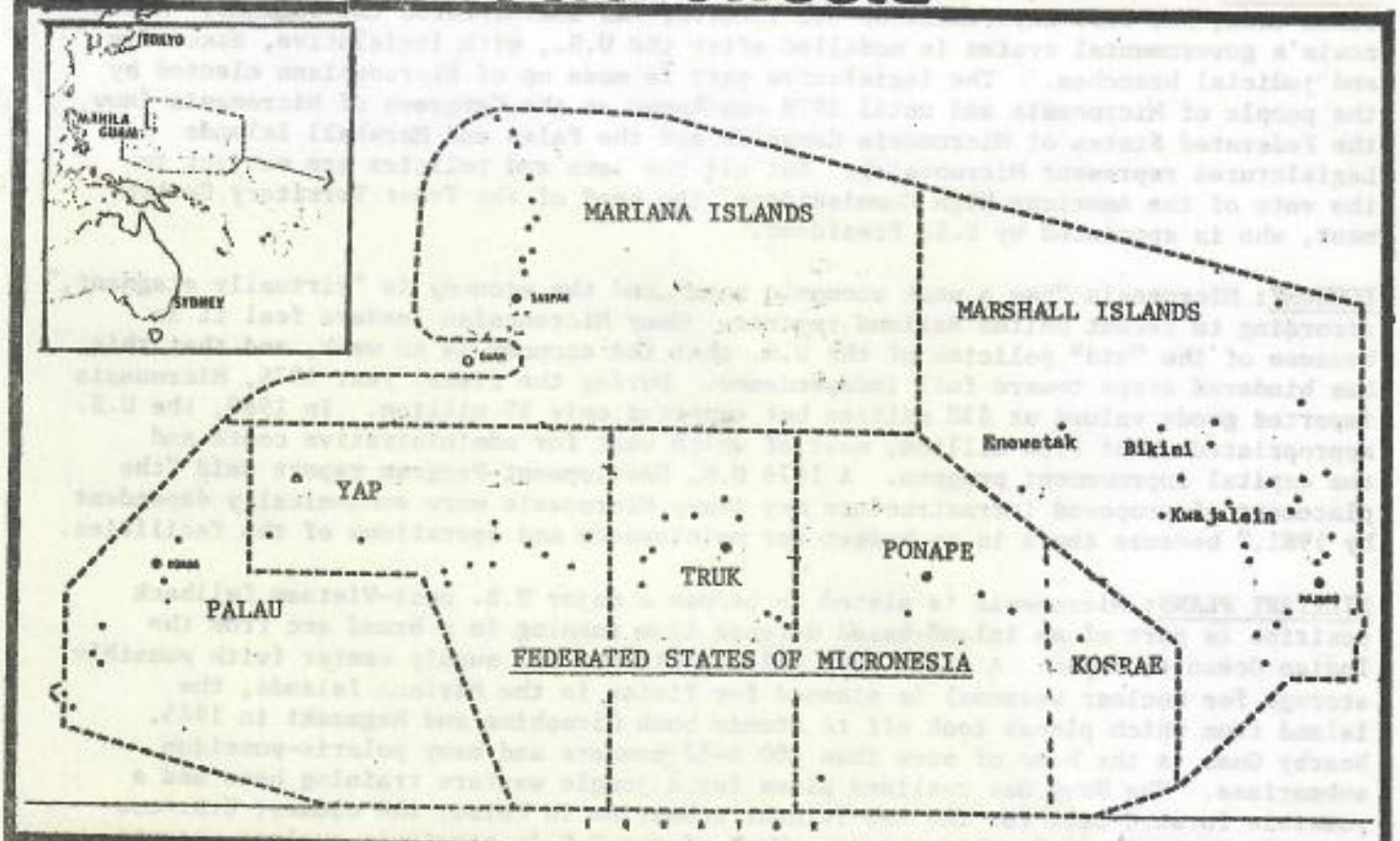
Sincerely,

GEORGE H. BALAZS
Assistant Marine Biologist

GHB:EC

Encl.

Micronesia



MICRONESIA is one of the three great island groups of the Pacific. Micronesia's three island chains—the Carolines, Marshalls and Marianas—contain 2,141 islands, about 100 of which are inhabited. The total population is about 115,000. Micronesia covers an ocean area the size of the continental U.S. The islands have been divided into six administrative districts which very roughly reflect cultural and language divisions. Since 1947, Micronesia has been controlled by the United States as one of eleven United Nations trusteeships. Micronesia is the only trusteeship which has not become self-governing. Micronesia is the only territory designated a "strategic" trust by the United Nations, giving the U.S. the right to build military installations there. The U.S. has used the islands for nuclear weapons tests, naval and air bases, missile testing, germ warfare experimentation and as a CIA training base for Nationalist Chinese guerrillas. In 1954, the people of two islands were severely injured by nuclear fallout from N-tests on Bikini atoll and some islands have been vaporized as a result of H-bomb tests. A massive oil superport, expected to solve Japan's need for increased oil storage capacity, is currently being planned for the Palau Islands by Japanese, U.S. and Iranian interests.

HISTORY: Micronesia was "owned" by Spain from about 1520-1898. Spain concentrated its colonization in the Mariana Islands, reducing the native Chamorros by genocide from about 100,000 to 10,000. The Americans won Guam in the Spanish-American War (1898), at which time Germany bought the rest of Micronesia from the Spanish. Japan gained control in 1914 and administered the islands under a League of Nations mandate until they lost the islands to the U.S. in bloody fighting during the Second World War. Since 1947, Micronesia has been administered by the U.S. as a United Nations trusteeship. Its future status is now being negotiated.

GOVERNMENT: Micronesia was run by the Department of the Navy until the early 1950's. Since then, the U.S. Department of the Interior has administered the islands. Micronesia's governmental system is modelled after the U.S., with legislative, executive and judicial branches. The legislative part is made up of Micronesians elected by the people of Micronesia and until 1978 was known as the Congress of Micronesia (now the Federated States of Micronesia Congress and the Palau and Marshall Islands Legislatures represent Micronesia). But all the laws and policies are subject to the veto of the American High Commissioner, the head of the Trust Territory Government, who is appointed by U.S. President.

ECONOMY: Micronesia "has a weak economic base" and the economy is "virtually stagnant," according to recent United Nations reports. Many Micronesian leaders feel it is because of the "aid" policies of the U.S. that the economy is so weak, and that this has hindered steps toward full independence. During the fiscal year 1976, Micronesia imported goods valued at $38 million but exported only $5 million. In 1980, the U.S. appropriated about $130 million, most of which went for administrative costs and the capital improvement program. A 1976 U.N. Development Program report said "the placement of proposed infrastructure may leave Micronesia more economically dependent by 1981," because there is no budget for maintenance and operations of the facilities.

MILITARY PLANS: Micronesia is slated to become a major U.S. post-Vietnam fallback position as part of an island-based defense line running in a broad arc from the Indian Ocean to Japan. A giant $300 million airbase and supply center (with possible storage for nuclear weapons) is planned for Tinian in the Mariana Islands, the island from which planes took off to atomic bomb Hiroshima and Nagasaki in 1945. Nearby Guam is the home of more than 100 B-52 bombers and many polaris-poseidon submarines. The Navy has outlined plans for a jungle warfare training base and a possible forward base for the new Trident submarine in Palau, the closest U.S.-controlled territory to Southeast Asia. Most of the U.S.'s strategic nuclear weapons delivery systems have been tested and continue to be developed at the Kwajalein Missile Range in the Marshall Islands.

NUCLEAR WASTE DUMPING: Since the mid-1970's the U.S. Department of Energy has been studying the possibility of sub-seabed storage of nuclear waste containers in the ocean north of the Northern Marianas. More recently, the Japanese government has announced plans to begin a two to three year "experimental" dumping program of approximately 10,000 barrels a year, in waters between Japan and the Marianas. Strong opposition from Micronesian and other Pacific Island leaders has forced the Japanese government to delay their plans, originally scheduled to begin in early 1981.

FUTURE POLITICAL STATUS: Since 1969, Micronesia has been negotiating with the U.S. for a new political status. In 1971, Micronesia rejected outright a U.S. offer of commonwealth. In ensuing rounds of talks, a "Free Association Compact" has been negotiated which would allow Micronesia to control internal and foreign affairs, but would give the U.S. full responsibility for defense of the islands.

In 1972, after Micronesia rejected the U.S. commonwealth proposal, the U.S. used its strong influence in the Marianas to begin separate negotiations for commonwealth status. Military "requirements" for 2/3 of Tinian island and other parts of the Marianas were an integral part of the negotiations. Marianas and U.S. negotiators signed the commonwealth agreement in 1975, the voters approved it in referendum and the process was completed in 1976 when President Ford signed the commonwealth into law.

Following the example set by the Marianas -- and because of additional military plans for Palau and the Marshalls -- the U.S. recognized those two districts to negotiate their political status separately. Thus, Palau, the Marshalls and the Federated States of Micronesia, representing the remaining districts, now make up the Micronesia side of the talks.

FOR FURTHER INFORMATION: Micronesia Support Committee, 1212 University Ave., Honolulu, Hawaii 96826.

MARSHALL IS. FILE

per X 3-4-83

Feb. 28, 1983

George,

In regards to NOAA's "Review of Marine Mammals, Sea Turtles, and Marine Fishes Listed as Endangered or Threatened", send a copy to:

Minister Kessai Note
Dept. of Resources & Development
Majuro, Marshall Islands
96960

No replacement have been found for my old position. The Secretary of Resources and Development has been suspended pending investigation of his alleged mishandling of departmental funds. His temporary replacement is useless. Send your data/info directly to Kessai.

Bill

Bill

P.S. Mention my name.

KAISER 20lbs Measure by eye
Talbs

March 4, 1983 Bourke - 259-7622 (or Conquist) 259-7951

George,

Mornings

Too bad about our trip to Bikar. Yes, by all means let's try and plan for next summer. Just as well...I got a phone call via the new satellite hook up in the Marshalls and learned that the government did not purchase one of the San Diego trollers. We would have had to secure another means to going to Bikar. Maybe next year the Maritime Authority will have their patrol boat. Better yet.

Mederios just left for the mainland yesterday. He has gone back to California to work in a machine shop to make a few bucks. Said he will be back in 3-4 weeks and then fish 3-4 weeks and then go back to the States, work 3-4 weeks, come back for 3-4 weeks, and so on.....Our turtle tagging project is now held in abeyance. I don't think you will have a chance to catch him on Molokai during your vacation unless you reschedule for the ending of this month. His nets are drying on the racks.

I just bought a small Boston Whaler. Bring over your dive gear (and your golf set) and maybe we can go chase some turtles down. I have to go into the Waikane area to check out a FAD that drifted in fromGod knows where and I'll hold off on it until you arrive if you want. I'll need the company anyway.

Don't recall ever hearing about anyone seeing seals in the Marshalls. I know a few guys from Maloalap and I'll check into it. Very interesting.

I've heard about Walter Ritte's proposed project in the Keawanui area on Molokai. Wants to bring about a "native style" living. We've waved to each other passing on the road but have yet to sit down and talk. I'll remember your connection if he and I ever get into a discussion.

Markrich has not been around yet. I'd be very interested in reading what he says about the "turtle controversy". I'll let you know if he touches base with me. I haven't heard from Don Heacock for quite a while. I do know that SUS Ono loaned his services out to the Disaster Relief program. Don't know if that is all pau yet. I'll give him a call soon.

Do me a favor, will you? Check with you contact at the Waikiki Aquarium and see if they're willing to buy fresh, live opae to feed their animals. Also see what kind of price they are willing to pay. If it's feasible may be able to work something out and make a few bucks on the side. Just a thought. (Times are hard! Electricity cost is killing me. My kids have a bad habit too...they like to eat everyday!) Besides the Aquarium, maybe Sea Life Park would be interested in a steady supply of live opae. What do you think?

Aloha,

Bill

BRUCE 1" or 1/4" (bright red) ?
— most frozen

Home -
553-3778

Feb. 3, 1983

George,

In regards to your letter of 1/31/83, I'll try to answer your concerns one at a time.

1. There is no reliable source (chiefs included) that can give you a definitive answer as to when the highest occurrence of turtle nesting takes place on Bikar. Bikar is so far out of the way that it had very little human contact. I had a guy (Reynold) working for me that passed this on: 40-50 years ago one of the deBrums from Likiep atoll own a 50' sail/motor launch and made 5-6 trips to Bikar from Likiep. The trips always coincided with the summer months for obvious reasons... calm waters. Reynold (who is a de Brum also) as a young boy remembers clearly one occasion when a multitude of turtles swarmed the beach on Bikar to lay their eggs...so much so that many previously laid eggs were destroyed by the mad scramble of nest digging by incoming turtles. Apparently this is not as uncommon as one might think because the Marshallese have a singular term for this event. I believe it also happens in other places such as Jemo, Erikup, maybe Taka and even remote islets of inhabited atolls. In any case, most if not all the turtle expeditions in the past were conducted during the summer months. As a result, the only kind of answer for the highest occurrence of turtle nesting you will get will be the "summer time" or "calm season". As an aside, the President recently made a trip to Bikar this past summer and returned with some turtles. Prior to that, I led the last expedition to Bikar in Sept. 3, 1978 and prior to that it was unvisited for at least 10-15 years (except for any unknown and unauthorized visits by Japanese fishing vessels). In sum, the summer months would be our best bet to go to Bikar. The weather is mild and we know turtles have nested there at this time. I can assure you that I personally saw 15-20 turtles coming up on the beach to lay eggs on the night of Sept. 3, 1987. We only stayed there for one night before departing to Taongi Atoll...which is even more remote.

2. Cost of vessel: I was personally assurred by the Secretary of Foreign Affairs, Tony de Brum, that a government vessel and crew will be available at our disposal. The Marshall Islands Maritime Authority also falls under the direction of Tony. Charles Domnick, the Minister of Finance, volunteered to obtain the necessary permission from the local chiefs. Advance work in both these areas have already begun. All that is left for us to get is permission from the Central Government which will be handled through the Minister of Resources and Development, Kessai Note. Charles and Tony have already made Kessai aware of our desires. I see no problems there. As to the cost of the vessel, all we have to provide is fuel for the vessel and food for us and the crew. I can't imagine the cost for fuel and food to be more than $3,000.00 U.S.

3. The run from Majuro to Bikar should include a minimum of two stops both way in my opinion. If so round trip will be about 5 days. Since the boat will be at our disposal, we can take any course we want and choose whichever atolls and as many stops we want to make. I would suggest Erikup, Jemo, and Utrik at the least. We can tag turtles on all of these atolls also. If time is going to be a problem, you (& I)

can fly from Majuro to Utrik on the Government's Nomad and rendezvous with the boat there for the last leg to Bikar. That will cost about US$150.00 more per person.

In sum, I think we can get away with US$5,000.00:

1. round trip Hono/Majuro for two.....$1,000
2. fuel & food for vessel trip.....3,000
3. misc., hotel in Majuro, car, meals, etc....1,000

$5,000

If you pick the amount of time you want to spend on Bikar, we can schedule your time commitment much easier. If for instance, you want to spend only a week on Bikar, we can arrange for you be away from Honolulu for about 10-11 days. You fly into Majuro and then fly directly up to Utrik and the vessel can be there to meet you...and vice versa. I should depart Honolulu at least one week prior to you to assure that everything is lined up...unless you want to spend an extra week in Majuro. I figure August would be our best bet...guaranteed calm weather by then.

TENATIVELY,

We will be using a former San Diego troller which used to fish for albacore at Midway. We'll probably have a crew of three Marshalleses. We're bringing our own ACE mechanic along with us from Molokai. A real nice guy by the name of Tommy Matayoshi who is a crakerjack mechanic and an avid diver and fisherman wants to go with us. He's paying his own way. We're lucky to have him along. You never can tell! I also want to take my son Mickey. I'll pay his way.

It will be a very good trip...actually maybe once in a lifetime kind. GEORGE, I GUARANTEE YOU'LL TAG TURTLES IN THE MARSHALLS!!! Rose gotta be nothing compared to the northern atolls of the Marshalls. You'll see and do things very few Westerners get to do. This trip has the PULELOA SEAL OF APPROVAL!! Don't chicken out now. Pick the amount of times and days you want to spend there and let me know as soon as possible so I can start firming up things.

In regards to your 59 Chevy, I (and Tom Matayoshi) can't remember off hand seeing one around, but we'll keep our eyes opened now that we know you're looking for one. Body parts or engine parts? What kind you need? Tommy says some of the 1960 body parts are interchangeable with the 59 Batman Car. Tommy works for DOWALD and is in the field most of the time. He'll keep his eyes open as he is always in the Hawaiian homestead areas...you know these Hawaiians, they buy the cars, run them until they die, and park them on their homesteads. I'm optimistic.

Mederios did not go out this week.

Aloha,

Bill

Notes from Data Log 1/3/79 telephone call - BILL PyLoLan -
Bill spent one night on Bikar. Japanese fish boat shipwrecked there from possibly one year ago. 8 nesters - 2 turned and taken. Nests seen all over. Also hawks and greens in the water of the lagoon. Black Tip sharks too.

Visited Taoqi - no evidence of nesting, but some turtles seen in the lagoon.

ERikup - coconut crabs - also a turtle preserve

Jemo - Turtle preserve

A couple of my Marshallese friends were in town (Honolulu) a couple of weeks ago. Everything's tentatively set for this summer for tagging turtles in the Marshalls. Boat and crew taken care of. All we gotta do is take care of the fuel and provisions. The government will take care of the rest...including obtaining permission from the traditional chiefs (iroij & alabs). All that is left to do is to dash off a letter of request and description of what we hope to do to the Minister of Resources & Development. I write something and send it to you for comments before sending it. Which letterhead are we using...Feds, State, your source of funding?

AREA	RECOMMENDATIONS (PCHP)	REMARKS
PALAU	1. Headstarting hawksbills. 2. Protection of Greens at Helen Reef and Merir. Tagging of same. 3. Stop sales of hawksbills to tourists.	Personnel changes (McVey, Owens).
YAP	1. Reinforce traditional restraints. 2. Grant 'cultural variances' for subsistence use. 3. Avoid use of Yap outer island turtles by others (incl. Trukese).	Traditional restraints still strong. Provided for in 1978 Regs. Pikelot turtles still exploited by Trukese. Intense Pikelot tagging might temper situation; or might start civil war.
GUAM & NMI	1. Endangered species act be enforced.	
TRUK	1. Cessation of capture and sale of hawksbills. 2. Institute field studies and tagging.	Capture continuing; level uncertain. Not yet begun. No plans.
PONAPE	1. Enforce U.S. law protecting hawksbills. 2. Declare Oroluk turtle sanctuary.	Law being enforced, but not in outer islands or outer villages. No action. Resident human population becoming permanent.
MARSHALLS	1. Strict enforcement of U.S. and T.T. law. 2. Conduct tagging or beach patrols to provide population estimates.	Main turtle islands controlled by one man or family.

MARSHALL ISLANDS DISTRICT

The Marshall Islands comprise a widespread District at the eastern end of Micronesia. With the exception of a few small isolated reef islands, such as Jemo, the Marshalls are comprised exclusivelt of atolls, most of which are made up of a few to many dozens of islets. The atolls are roughly aligned along two parallel axes, the northeastern being the Ratak Chain and the southwestern the Ralik Chain. None of the islands reaches a height of more than a few feet above sea level, and the total land area of the District is only 69.84 square miles. The human population, numbering 20,206 in 1970, is widely distributed, but only the atolls of Majuro, Kwajalein, and Ailinglapalap have more than a thousand people. Bryan (1971) lists Taongi, Bikar, Taka, Jemo and Erikub as the only atolls or islands that have never had human populations, while the people of Bikini and Enewetak were displaced after World War II when these islands were used for atomic weapons testing. Rongerik is listed by Bryan as having 6 people in 1935 and 1948, but as being uninhabited in 1970; this island was used temporarily by the displaced people of Bikini, but proved unsatisfactory. The Marshall Islands are well described by Anon (1965), while excellent maps and directories to names of islands and islets are provided by Bryan (1971). Anon (1957) provided the following historical information on the use of turtles in the Marshall Islands:

A. Methods of Capture or Killing

The northern Radak atolls of Bikar, Bokak (Taongi),Toke, the island of Jemo, and the islands of Lrik and Luij in Erikub Atoll have been used from time immemorial as game reserves by the Marshall Islanders. Periodically, turtles and their eggs were harvested there. The traditional practices of harvesting these animals and their eggs usually took place on special islands with the chief opening the season. Stylized and elaborate rituals were connected with these first food gathering expeditions of the year which occurred in the summer. This gathering was apparently done at the time when the turtles were ashore laying eggs. Both the eggs and the turtles would be taken at this time. Though turtles and their eggs are still taken the ceremonialism formerly connected with this activity is no longer practiced.

The ability of the Marshallese to capture turtles at sea depends to a great extent on the fact that the habits of turtles, an important source of protein to the atoll dwellers and highly prized by them, are well known, having been observed by them for centuries. Certain of the Marshallese know more than the others about these reptiles and their opinion and guidance is sought and respected.

B. Local Custom Regarding Capture of Turtles and Use of the Meat

As has been previously noted, expeditions were assembled to go to some of the islands known to be heavily populated by turtles. Upon arriving at the island the chief and all of the members of the expedition went ashore. The chief had to lead the first trip of the year and he was the first person to step ashore.

Before the party commenced their search for eggs, supernatural sanctions were requested. Everyone assembled on the beach, before proceeding in and cut a leaf of coconut frond. With the chief leading the way they walked in single file, each carefully stepping in the footprints of the person in front of his so that only one set of footprints would appear, as if only one person had been there.

The women were required to hold mats over their heads while on the island so that they could only see the ground well enough to gather the eggs and other items. Strict silence was observed. Often medicine was made by the chief from the leaves of a small rare plant (marutto). The leaves were pounded and the juice extracted and drunk by all to prevent anal bleeding and diarrhea which might result from an unaccustomed meal of turtle and birds' eggs. After the eggs were gathered the group assembled at a specified place before consuming any eggs. Four eggs were thrown in each of the four cardinal directions by the chief as an offering. These "sacrificial" eggs were then re-gathered and eaten by the leader of the party and the remaining eggs were then divided up and eaten by the others.

Turtle flesh was distributed according to a specified, traditional pattern but this custom is not followed today.

Only Kwajalein and Majuro were visited during the present survey. However, much useful information on turtles elsewhere in the Marshalls was provided by Ben Sablan on Ponape, who was formerly resident in the Marshalls; by Major Ron Barnett and Rev. Elden Buck on Kwajalein; Jim Hiyane, the Agricultural Officer on Ponape; George Balazs in Hawaii; and Jobel Emos, a janitor at the Kwajalein Missile Range. Valuable information was also obtained from the writings of Anon (1957), Hendrickson (ms), Fosberg (1969), Helfich (ms), and Hiatt (1951).

Bikar Atoll

The atoll of Bikar, one of the northernmost of the Marshalls, is generally thought to have the highest concentration of breeding green turtles in the District. The atoll is composed of several islets, the named ones being Jabwelo and Almani

on the east, Bikar on the south, and the sandbank of Jaboero between Bikar and Almani. Bikar is the largest with an area of 0.063 square miles.

Anon (1956) said of Bikar: "Sea birds of many kinds are abundant, but the outstanding feature is the great number of turtles that come ashore to lay eggs on Bikar Islet." Fosberg (1969) recounted his experiences with the turtles of Bikar as follows:

> Bikar Islet, the largest of the three, is of sand, except for areas in the interior where this has been cemented into phosphate rock. On the western and southern coasts are sand flats with rather open vegetation much frequented by turtles as nesting sites. An outstanding feature of these parts, especially on the south coast, is the way the sand has been churned up by turtles digging holes in it. On the afternoon of August 6th I counted 596 tracks. That night 6 more turtles came ashore, of which 3 were seen by the party. One was measured, being 70 cm across and 135 cm long. She was strong enough to move on land with a small man sitting on its back. When caught she shed tears. When released she headed back to sea, climbing over very rough pitted rock remnants with some difficulty, but successfully. A few turtles came ashore on each of the following five nights, on August 10 about 15. On August 11 three were seen, but probably more came ashore. One night one blundered through our camp, creating much havoc. One that was spotted coming out of the water was frightened by the light and turned back. Two more turtles were measured, one being 80 cm wide and 122.5 long, the other 70 cm wide and 115 cm long. Colors and patterns on shells were most varied.
>
> I watched one come ashore at 8:10 p.m., August 11, before the moon rose. She walked about 50 m. inland, poked her front end into a large Scaevola bush, stopped and began to scratch with her hind feet, gradually excavating a hole less than 30 cm across and as deep as the short hind flippers could reach, using a peculiar back-hand scooping motion with alternate feet, each time, while digging with one foot, flipping away the sand that was brought up by the other foot previously. This appeared to be a very inefficient method of digging. When the hole was finished the rear end of the turtle projected over the hole and the tail pointed downward. Eggs were expelled 1-2 or even 3-4 at a time, dropping into the hole. This turtle laid 92 eggs, taking 11 minutes for the actual laying process. Then she filled the hole very carefully with sand, which she patted and pressed down in a mound over the eggs. Gradually she spread this mound out and covered it with dead leaves, then dug a pit to one side and threw the dirt over the hole where the eggs were laid, making a low broad mound over it, so that one would

scarcely guess where the eggs were laid. The whole process took over three hours.

Newly laid eggs were seen from 3 different individuals, varying somewhat in size from turtle to turtle. In the clutch of 92 mentioned above was one tiny egg, the size of a marble.

The sand flats outside of and especially in the open Tournefortia belt around the Pisonia forest that covers most of the islet, were thickly spotted with the shallow pits, 60 cm to 1 m across, each with a low mound at one side. Two of these mounds were observed to have small holes in them, with numbers of small flies buzzing about them, and, in one case, hermit crabs in the holes. These holes may have been made by the hermit crabs, but were more probably made by young turtles emerging. One hole had a broken shell in it.

On the night of August 6 a few black baby turtles were seen hurrying toward the sea. They were being attacked by large red hermit crabs (Coenobita perlata) and by rats (Rattus exulans). The hermit crabs bit through the carapace, the rats through the plastron. On August 10 and 11, at about 8 p.m., batches of young turtles hatched out and came running through camp, on their way to the sea. They followed lights.

Almost all of the female turtles that visited Bikar Atoll, well over 300 in the 7 nights, August 5-12, came ashore on Bikar Islet. One set of tracks and a pit were noted on Jaboero Islet, a few on the south part of Almeni Islet, but none on Jaliklik Islet, which is rocky and has no loose sand.

The location of the hole containing the eggs beside the pit excavated by the turtle is in marked contrast with the situation in Malaya and Sarawak, reported by Hendrickson (personal communication), where the hole with the eggs is some distance from the pit.

In 1958 Bikar Atoll and Pokak (Taongi) Atoll, which lies to the north of it, were set aside as preserved natural areas by administrative decree by the then District Administrator, Mr. Maynard Neas. It is hoped that this protection may be strengthened, as clearly Bikar is the principal turtle nesting area in the Marshalls and should be kept as a stocking area for the rest of the archipelago.

Judging by the numbers given in the earlier part of this quote, it is possible that the "over 300" turtles is a misprint for "over 30."

From the large numbers of tracks seen, the relatively light nesting observed and the observations on hatchlings, it appears that the season on Bikar reaches its peak probably around June and July.

Hendrickson (ms) was able to visit Bikar on July 2-3 1971 and made the following observations:

> The consultant visited Bikar Atoll and all three of its islets judged suitable for green turtle nesting (Bikar, Arumeni and Jaboerukku). These are the only vegetated islets in the atoll, the remainder being barren bars and banks which are presumably swept by high wave action. The timing of the visit was particularly favorable, being at the end of a seven-day period of diminishing tides during calm weather. This left a series of high tide marks on the clear areas of beach where rocks had not confused the wave wash pattern and, for the most part, it was possible to identify the night on which recent beach ascents had been made by nesting turtles, by noting the particular high tide mark where the track ceased to be evident. It was possible to say with some confidence that 39 turtles had ascended the beaches during the preceding six days (78 tracks, half ascending, half descending). Thirty five of the 39 turtles had used the beach on Bikar Islet, one had ascended Arumeni, and two had ascended Jaboerukku. One of the 35 tracks on Bikar was a hawksbill track (not Ridley); all others were presumed made by green turtles (Loggerheads have not been reported from the area).

Hendrickson made some calculations of the possible size of the nesting population on Bikar, concluding that the order of magnitude of the population was 711 sexually active adult female turtles in the Bikar breeding population. From these figures, he reasoned that "even the most favorable interpretation of the data available (granting the assumptions made) allows consideration of a population of only small size, not constituting an exploitable wild resource of any significant magnitude."

Jemo Island

Jemo is an isolated, tiny island situated at 10° 8' N, 169° 32' E, located between the atolls of Ailuk and Likiep. The land area of Jemo is only 0.06 square miles. The turtles on Jemo were described as follows by Anon (1956):

> Many turtles visit Jemo to lay their eggs. Jemo was formerly tabu for most of the year, being regarded as a bird and turtle reservation. Only during one month in the year were these animals hunted and their eggs taken.

Fosberg (1969) visited Jemo from December 18 to 22 1951 and observed tracks corresponding to the nesting of 22 turtles during the past several days. A nesting turtle observed by Fosberg measured 75 cm across and 120 cm long (presumably total length).

The Rev. Elden Buck of Kwajalein informed me that a boat from Likiep sometimes brings ten to fifteen turtles for sale on Ebeye. These turtles were presumably caught on Jemo, which is the closest turtle island to Likiep. Likiep itself has few turtles, according to Ben Sablan on Ponape. Further confirmation of the presence of nesting turtles on Jemo was provided by several informants during my survey.

Arno Atoll

Green turtles nest occasionally on the sandy beaches of Arno Atoll but they are scarce and of no commercial importance (Hiatt 1951). Ben Sablan reported that nesting on Arno takes place on the islet of Ine, in the south and southwest.

Erikub Atoll

Erikub is an uninhabited atoll composed of 16 islets lying just south of the inhabited atoll of Wotje. Jim Hiyane, the Agricultural Officer on Ponape, informed me that he had seen turtles nesting on Erikub, and estimated that 6 or 8 turtles nested nightly. He mentioned that people from Wotje go to Erikub for copra, coconut, crabs, etc., and often picked up turtles when there, but did not go specifically for turtles.

Jobel Emos on Kwajalein confirmed that turtles nested on Erikub, and pinpointed the northwestern islets of Enego and Loj as being the most favored for nesting. Emos claimed that nesting on Erikub was year-round, but that the turtles were usually exploited during the summer months because of the prevailing calm water at that season. He said that the Wotje people, when they caught a female turtle on Erikub, would tether it in shallow water so that it would attract males, which were captured as they mounted her. Emos' estimate was that 3 or 4 turtles nest nightly on Erikub.

On Kwajalein, the Rev. Buck showed me a photograph of a boatload of over twenty turtles that had been brought in from Erikub and Bikar for sale on Ebeye, the islet where the Marshallese workers on the Kwajalein Missile Range reside.

Taka Atoll

Taka is an uninhabited atoll lying very close to, and southwest of, the inhabited atoll of Utirik. It has five islets, the largest of which is Taka itself (0.0996 square miles). According to the Rev. Buck, people from Utirik collect turtles and turtle eggs on Taka, but further details are not available.

Ebon Atoll

Ebon is the southernmost of the Marshall Islands. It is a roughly circular atoll composed of 22 islets, by far the largest of which is Ebon itself, an elongate island that makes up the southern side of the atoll; it is about six miles long and has an area of 1.083 square miles. Bryan (1971) lists the 1970 population of Ebon as 480 - substantially reduced from the 1935 and 1948 censuses. Ebon has a reputation for abundance for foods of all kinds, and although no definite information on turtle nesting was available, it is considered to be the best area for catching turtles in the water. The turtles are nearly all of adult size and are caught with nets. Two to four can be caught per night. An interesting observation passed on to me by the Rev. Buck was that, if a turtle on Ebon is captured in a certain place, the next night it is often found that another turtle has moved to the same spot.

Electromagnetic Radiation to 195,000

Kwajalein Atoll

Kwajalein is the largest atoll in the Marshalls, and reputedly the largest in the world. 93 islets are listed by Bryan (1971). The atoll is of irregular, meandering shape, generally elongate in form with the eastern end bent sharply downwards and the northern part formed into a point. The islets of Kwajalein (at the southern tip) and Roi and Namur (now connected by a runway and called Roi-Namur) are devoted exclusively to U.S. military uses. The Marshallese residents live on Ebeye, a small and highly overcrowded islet a short distance north of Kwajalein, on the eastern edge of the atoll. Most of the other islets are very small, and in some parts the bounding reef is without islets for distances of ten or fifteen miles.

Major Ron Barnett on Kwajalein gave me considerable information on turtle observations on Kwajalein. Turtles are often seen around Kwajalein Islet, and between Kwajalein and Ebeye. A few turtles appear to be extraordinarily static

in range; a certain green turtle is reported to have resided at a certain coral head (known as K5) off the lagoon shore of Kwajalein for 2 to 3 years, and is very familiar to skin divers. Green turtles are also seen on the ocean side of Kwajalein at the end of the runway, where they scavenge for the kitchen scraps that are thrown in each day. Major Barnett described how turtles are caught by children on the island off the ocean side of Kwajalein; a fishing line is equipped with a hook baited with bread and a children's balloon; the trade wind carries the balloon to the edge of the reef, where turtles often take the bait. Most turtles break the line or otherwise escape, but an estimated 25 turtles per year are caught in this fashion. They are usually of less than mature size. One turtle that I saw feeding on the kitchen scraps on Kwajalein, however, appeared to be of adult size.

Turtles are maintained in captivity in two pools on Kwajalein; one pool contained two yearling green turtles, while the other contained about ten half-grown greens and one nearly mature hawksbill, reportedly from Ebon.

No records are available for turtle nesting on Kwajalein, and indeed there is a shortage of good beaches. However, much of the atoll is poorly studied, and a Marshallese informant on Kwajalein informed me that turtles do nest sometimes on the islands at the northwestern end of the atoll (the islets from Keko to Boggerik, known to the Americans as Hamel, Hamilton, Hampton, Harden, Harland, Harley, Harvey, Henry, Herald, Herlet, Herman, Herschel, Hollis and Homer).

Ujelang Atoll

Ujelang, or Ujilang, is an elongate atoll about thirteen miles long located at the western extreme of the Marshalls, being closer to Ponape than to the population centers of the Marshalls. It had a small native population of about 40 people (plus twelve non-natives) in 1935. It was uninhabited in 1948 according to Bryan, but this is presumably in error, since Helfich (ms) reports that the Enewetakese people displaced by atomic tests were settled on Ujelang in 1947. The 1970 population, according to Bryan (1971) was 281.

Ujelang is listed by Carr (1965) as a 'minor nesting beach' for the green turtle. The source of this information was not quoted, but Carr informs me that he based this record on an observation made by the crew of a U.S. Naval vessel anchored off Ujelang one night in 1962. Baby green turtles were attracted to the lights of the ship in very large numbers - though at this point it is not possible to ascertain whether the numbers represented only one or two successful nests, or whether there were numerous nests erupting simultaneously. Two of these hatchlings were transmitted alive to Dr. Carr. Phil Helfich, in a brief manuscript report communicated to me through the courtesy of George Balazs, reports on an interview with Chief Johannes, chief of the exiled Enewetakese people on Ujelang. In this report, Helfich stated: "Chief Johannes indicated that turtles nested all around the island Ujilang. Ujilang is the island which

has been occupied by the Enewetakese since 1974, and it is difficult to visualize that they did not decimate the nesting turtle populations, because Ujilang is such a small island."

None of the informants on my survey had any information about turtles on Ujelang. The island is extremely remote and is not often visited. This would appear to be a priority for future studies.

Enewetak Atoll

Enewetak is a rather large, almost circular atoll in the western Marshalls. According to Bryan (1971), it is composed of 44 islets, has a land area of 2.26 square miles and had 128 people in 1948, but none in 1970. However, Anon (1972) wrote that there are now 100 people, mostly civilians, living on Enewetak. Anon (1975) gives 1947 as the year in which the 136 Enewetakese residents were transfered to Ujelang; the island was used for nuclear tests between 1948 and 1958. Since 1954, the University of Hawaii has operated the Mid-Pacific Marine Laboratory on Medren Island, Enewetak.

Helfich (ms) quotes Chief Johannes of Enewetak, who lived on the atoll until 1946, as reporting turtle nesting (up to 1946) taking place from May through August on the islets of Alice, Bell, Runit (Yvonne), Glen through Keith, Leroy, Wilma, and Vera. The last two islands had the best nesting areas. Another islet by the name of "Vikai" was reported by Johannes to have abundant nesting turtles, but no island of this name is shown on available maps of Enewetak.

At the present time, there appears to be little turtle nesting on Enewetak. However, George Balazs has prepared reporting sheets for observations of turtles by scientists at the Mid Pacific Marine Laboratory and others, and valuable information may eventually be forthcoming from this program.

Majuro Atoll

Majuro, the District Headquarters, is an elongate atoll approximately twenty miles long. The southern rim of Majuro was originally composed of a single extremely attenuated island, Majuro, and a series of much smaller islands to the west. However, these islands have now been connected in order to provide vehicular access between the principal town (known as D-V-D, from its constituent and now coalesced islets of Carrit, Uliga, and Dalap) and the airport; and the blockage of the former passages between islets, with no provision for bridges or culverts, has led to substantial pollution problems in the Majuro lagoon.

Turtle nesting has not been reported on Majuro, although turtles are spotted in the waters of Majuro relatively frequently. Ben Sablan informed me that large turtles are seen resting near the Windward Islands of Majuro, and on an afternoon dive one summer he had seen more than fifteen turtles, all females.

Jaluit

Jaluit is a large, irregularly shaped atoll, about thirty miles long from north to south. It is composed of 91 islets. Bryan (1971) gives the 1970 population as 881, substantially reduced from former years. Ben Sablan informed me that turtles nest in small numbers on Lijeron Islet, near the northern end on the west side of the atoll.

Aur, Maloelap and Likiep Atolls

Ben Sablan reports that turtles may be found on each of these atolls but that in no case were they plentiful.

Bikini and Taongi Atolls

Although my informants did not mention these atolls, both were recorded by Hendrickson (ms) as being second in importance only to Bikar among the Marshall Island turtle nesting atolls. Hendrickson obtained his information about Bikini from Mr. Robert Ward, a heavy equipment maintenance supervisor for the Bikini Atoll Rehabilitation Project. Additionally, the popular move "Mondo Cane" made several years ago showed rather large numbers of dead green turtles on Bikini, though the interpretation made that these had been disoriented by radiation damage and had wandered into the interior of the island to die is somewhat questionable. I have seen dozens of dead green turtles inland from the nesting beach on Baltra Island, Galapagos. This island appears to lack the normal sea-finding (or land-fleeing) cues that enable a turtle to identify the proper heading for the ocean.

Recommendations - Marshall Islands

It is no coincidence that the turtles' nesting islands in the Marshall Islands at the present time are not only uninhabited by man, but they are also in nearly all cases parts of totally uninhabited atoll systems. In islands as small as

the Marshalls, man has to look for food from the sea; and turtle provides a welcome change of diet from fish. It is likely that even on the uninhabited islands the turtles have only been saved from extermination by man by taboos and primitive management and closed season customs, now fast dying. I concur with Hendrickson that the green turtles of the Marshall Islands do not at the present time constitute a renewable resource of any significant magnitude.

The present recommendation, therefore, is to urge the strictest possible enforcement of both U.S. Endangered Species Law and the Trust Territoy Code as they relate to sea turtles. This would provide protection for the now very rare hawksbill turtle, and would also protect undersized and nesting green turtles. It has been suggested by some turtle biologists that if some human use of a turtle resource is unavoidable, then it should be aimed at the young turtles rather than the grown ones; however, to inject such thinking into the Trust Territory Code at the present time would create far more confusion than is justified.

The second necessity is to conduct tagging and beach patrols on the islands reputed to have good or even surviving nesting populations of green turtles. In this way, a turtle population estimate for the District could be made, migrations of the turtles could be monitored, and figures could be obtained on the number of turtles illegally removed from the nesting beaches each season. In contrast to the Yap District, there is no evidence that turtle capture in the Marshall Islands is a culturally important activity, and now that motorized vessels and modern navigation equipment is available, remoteness no longer serves as adequate protection for a turtle beach. There is no justification therefore for "cultural variances" from either Federal or TT law in the Marshall Islands District.

DISPOSITION FORM

Memo!

For use of this form, see AR 340-15, the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL	SUBJECT
PODED-PV	Trip Report 5-9 June 1978, Kwajalein Missle Range

XXX THRU: C, Env Res Sec
C, Planning Br

FROM R. Shallenberger
B. Moncrief

DATE 21 Jun 78
Shallenberger/tl/2264

CMT 1

TO: MEMORANDUM FOR RECORD

1. PURPOSE OF THE TRIP: The purposes of this trip were to gather data on abundance and distribution of terrestrial wildlife, assess impacts of KMR operations on avifaunal habitat and to evaluate the area as habitat for marine turtles. The wildlife data were gathered to assist in updating of the environmental assessment of KMR operations. Turtle research was also directed specifically to fulfill a presidential directive (23 May 1977) for all Federal agencies to identify lands under their jurisdiction that are critical to the survival of species presently determined to be endangered or threatened under provisions of the Endangered Species Act of 1973.

2. ITINERARY:

5 June 1978 - MAC Flight 533 (Hickam to Kwajalein)
Terrestrial Survey on Kwajalein
Orientation with CPT Richard Whitney, POD

6 June 1978 - Orientation/scheduling with KMR personnel and TTPI liaison officer.
Helicopter Survey of east reef and atolls.
Terrestrial Survey on Gellinam and Omelek
Boat Survey of east reef and atolls (landing on Bigej, Ningi, Gugeegue, Ebwaj, Loi, Ebeye)
Survey of turtle ponds on Kwajalein

7 June 1978 - Scheduling with KMR personnel
Helicopter Survey of southwest atolls
Helicopter Survey of northwest reef and atolls (Landing on Biggerann Oniotto, Biggarenn)
Boat survey of southwest reef and atolls (Landing on Ninni and Gea)

8 June 1978 - Scheduling with KMR personnel
Helicopter to Ennylabegan, then ground survey
Helicopter Survey of entire southwest and south reef and atolls, beginning at Yabbenohr. (Landed at Eru, Nell, Illeginni, Onemak, Legan)
Helicopter direct to Eniwetak for ground survey
Tagging of hawksbill turtle on Kwajalein

9 June 1978 - Tagging of hawksbill turtle on Kwajalein and meeting with personnel caring for captive turtles
MAC flight 534 (Kwajalein to Hickam)

PODED-PV 21 June 1978
SUBJECT: Trip Report 5-9 June 1978, Kwajalein Missle Range

3. PERSONNEL: The success of this brief survey was dependent upon the cooperation of several people at KMR who assisted in logistical support and provided important information.

COL Ernest van Netta, Commanding Officer, KMR
CPT Richard Whitney, Corps of Engineers, Kwajalein Office
Mr. William Barnett, KMR
Mr. Robert Haley, TTPI Liaison Officer, KMR
Mr. Charles Dance, Air Operations Officer, KMR
Mr. Paul la Pointe, Boat Skipper, Global Associates
Mr. Mike Kabua, Island Owner (Oniotto Island)
Mr. Jorlanin, Island Owner (Biggermann Island)
Mr. Michael May, Caretaker of turtles on Kwajalein
CPT Lull, Helicopter Pilot
CPT Brown, Helicopter Pilot
Various other Marshallese residents on atolls visited

4. SUMMARY OF TRIP RESULTS:

a. Avifaunal Survey. The results of this avifaunal survey will only be briefly summarized in this report, and included in more detail within the updated KMR environmental assessment. Twenty-one islands were briefly surveyed from the air and on the ground, and 31 additional islands were surveyed from the air along (See Map). We were unable to survey islands in the immediate of Roi-Namur during our trip due to limited time available and conflicting schedules of range operations. However, evaluation of aerial photographs and other data makes it possible to extrapolate data from the several islands we did visit to those we did not.

(1) Historical data on Avifauna in Kwajalein atoll are limited in scope. A recent summary of bird records for Kwajalein, published by the Smithsonian Institution, includes a list of 30 bird species recorded historically from the atoll. Of these, only two are true land birds. The rest are seabirds, shorebirds or waterfowl, many of which are migratory species that visit or pass through Kwajalein only in their non-breeding season. Data on the breeding status and distribution of these birds in Kwajalein atoll were very incomplete prior to our survey. Of the 30 species recorded historically at Kwajalein, 15 were observed in this study. Most of those species not recorded during the present study have been seen at Kwajalein only during winter months, and many of these represent only single records. We recorded a single individual of one species (Wedge-tailed Shearwater, Puffinus pacificus) not recorded historically at Kwajalein atoll. This species has, however, been noted at other atolls in the Marshalls group. On this survey, we confirmed breeding for two species (Red-footed Booby, Brown Booby) for which nesting was previously unrecorded, and confirmed presence in summer months for two species (Bar-tailed Godwit, Bristle-thighed Curlew) not previously recorded other than in winter months. Most significantly, the present survey provided important distributional data not previously available, particularly for islands west of Roi-Namur and for the entire southwest part of the atoll. The most common nesting bird on this survey was the Black Noddy (Anous tenuirostris), found on all islands except Kwajalein and Meck.

(2) The long history of human occupation has taken an obvious toll on Kwajalein birdlife. The forest on most islands in the atoll is dominated by Cocos (coconut palm), providing a source of food and income (copra) for the Marshallese. Although some seabirds may roost in Cocos, nesting in this tree is very rare. Resident tree nesting marine birds prefer other native trees, particularly Pisonia and Messerschmidia. Although these trees can be found on virtually all Kwajalein atoll islands, dense natural Pisonia forests remain only on those islands that were not cleared and replanted in Cocos or altered by military operations and/or current KMR programs. Actually, the only islands we visited that retain a significant portion of their presumed pre-human vegetative condition were Oniotto, Eniwetak, Gellinam and Omelek. Surprisingly, the latter three of these are now the site of KMR facilities (helipods, towers, tracking stations). In the specific location of the KMR facilities, forest has been eliminated, yet elsewhere on these islands the native forest remains essentially intact. This is true to a lesser degree on Illeginni as well. The forest on each of the islands provides nesting habitats for seabirds, particularly the Black Noddy (Anous tenuirostris). However, the abundance of rats (particularly Rattus exulans) probably precludes successful colonization of these islands by ground nesting birds. Oniotto Island, in the more remote northwestern portion of the atoll was the only site where we observed ground nesting birds (Brown Boobies, Sula leucogaster). Although a Marshallese resident with us indicated that some rats were on this island, we did not confirm their presence here, but found them commonly on many other islands.

(3) Habitat for migratory shorebirds has not been significantly degraded by either Marshallese or American occupation of the atoll. In fact, grass lawns on Kwajalein (and presumably on Roi-Namur) attract numerous shorebirds of several species. Most have accommodated to human presence in these populated areas. In contrast, shorelines and fringing reefs provide even greater amount and diversity of shorebird habitat. These areas have been disturbed only to a small degree and it is highly unlikely that the migratory species are in any way limited in the atoll by lack of suitable habitat.

(4) It appeared clear that resident Marshallese have had far more significant direct impact on terrestrial wildlife, particularly birds, than has the KMR human population. All of the resident seabirds are taken as food by the Marshallese. Impact on nesting colonies is only minimized by the concentration of Marshallese population on islands where seabirds are in low numbers or not a resident at all. Yet the large piles of burned bird bones on the most remote islands made it clear that no place or resource was sacred. In our aerial surveys, we did not visit a single island in which human footprints did not encircle all or nearly all of the island.

b. Clearing Activities. The most significant habitat loss has occurred historically through clearing of natural vegetation and replanting with Cocos. This activity continues to this day, with assistance of the United States government. Eleven islands in the mid-atoll corridor have been identified for clearing and replanting with Cocos. To date, it appeared that six had been cleared and only one (Bigej) was partially replanted. Both bulldozer and "controlled" fire had been used in clearing. The clearing program was initiated

in the most recent lease agreement to help the Marshallese restore copra harvest activities on islands from which they were evacuated for KMR programs. The intent is to clear the islands with bulldozers and bring in sacks of Palauan coconuts (reported to grow shorter, but faster) for the Marshallese to plant. In practice, the project has not achieved the desired result to date, because the Marshallese have not planted the coconuts on most of the cleared islands and where they have, other plant species (particularly Scaevola) are growing faster and shading out the young Cocos trees. On one island we visited (Onemak) Marshallese had destroyed many of the coconuts by cutting tops off for milk, and the only Cocos beginning to sprout in the barren area were from nuts ground under the sand during the clearing operation. This and other recently cleared islands are now surrounded by a dense peripheral "berm" of felled Cocos and other trees that were destroyed for a program destined for questionable success. Although supported in the lease agreement by Marshallese representatives, it is unclear why a project of such magnitude did not require an evaluation of environmental impact, particularly as it relates to biological and historical resources, and social impacts as well. It is certainly of far more lasting significance than many of the projects for which POD has reviewed permits and prepared detailed assessments. It is still possible to put a stop to additional clearing operations, at least until the impacts can be evaluated and perhaps until the success or failure of the program to date can be determined.

c. Turtle Survey. Data on the distribution and abundance of marine turtles in Kwajalein atoll is based on observations of tracks of nesting turtles, information obtained from Marshallese and American residents and limited historical information provided in "Marine turtles of Micronesia," 1977.

(1) Historical information consists of reports by Marshallese informants of nesting activity in the northwest islets of the atoll and the sighting of a nesting Green turtle on Begej on the east reef by boy scouts in 1976.

(2) Considerable information was provided by Mr. Jorlanen, our Marshallese guide on the northwest islands survey. According to him, heaviest nesting activity occurs between March through August. Both Hawksbill and Green turtles nest in the northwest islets, however, Hawksbill turtles are uncommon. Mr. Jorlanen (and other Marshallese) can differentiate between the two species by egg size, the Hawksbill having a smaller egg than the Green turtle. Hawksbill tracks on the beach are also reputed to be narrower than those of Green turtles, due to smaller size of the mature female Hawksbill. Marshallese eat the flesh of both species but only the eggs of the Green. When a fresh nest is discovered all the eggs are taken. Evidently, no conservation measures are practiced. Clearly the ability of turtles to sustain populations is dependent on successful nesting that somehow goes undetected on remote atolls.

(3) The two helicopter pilots who assisted in our survey said that they sight turtles regularly during flights up and down the east and south reefs. Those turtles occur in both lagoon and ocean waters, usually as single individuals but occasionally in groups of two or three. No large concentrations of turtles

have been observed. During our survey, due partly to altitude and speed during flight between islands and strong tradewinds creating choppy sea surface conditions, observation of turtles in the water was difficult. Only two such sightings were made, both on the lagoon side of the south reef during an aerial recon of the south reef islets for turtle tracks and suitable nesting sites.

(4) The following is a summary of suitable nesting sites and observed nesting areas for four regions within the atoll:

(a) Northwest reef and islets (Biggerann to Biggerenn). All islands surveyed had ample suitable nesting areas. Turtle tracks were observed on all islets, with the greatest number (9 sets of tracks) occurring on Etcharai and Oniotto. A total of 32 sets of tracks were observed on the five islands surveyed.

(b) Southeast reef and islets (Gellinam to Loi). Of the nine islets surveyed only three had beaches suitable for nesting. These were Eniwetak, Bigej and Ningi. No tracks of nesting turtles were observed on any of these islands during the survey. However, several Green turtle hatchlings had been discovered recently on Meck Island, and were taken to the bachelor club turtle ponds on Kwajalein where we observed two of the survivors. Since Meck Island has no suitable nesting beaches, the juvenile turtles were evidently carried to Meck by strong prevailing currents from a nearby islet. It is likely that they came from Eniwetak or Kwadack less than 1 mile northwest of Meck, since these are the only islets close to Meck with potential nesting beaches. In any case, the presence of these hatchling turtles suggests recent nesting activity taking place within the east reef islets. We spoke with a Marshallese resident on Bigej who had captured a Green turtle (approximately 22" carapace length) and was keeping it alive on a fishing line. He indicated that Hawksbills never come up onto the beach at Bigej. He said that Green turtles nested on Bigej, but not every year. He confirmed that the islands on the northwest reef, as far west as Ebadon, were the best sites for nesting turtles of both species.

(c) South central reef and islets (Yabbenohr to Ennugenliggelap). Nine islets in this group had beaches suitable for nesting. A total of 15 sets of tracks were observed on seven of these islands. Boggenatjen was the only island with any concentration of tracks (6). Human presence on all of these islands was evidenced by lean-to structures, camp sites and tracks. On Onemak, the recent clearing operation to facilitate coconut planting had created a high impenetrable berm of dead trees and brush along the upper margin of the beaches, blocking access to potential turtle nesting areas.

(d) Southwest reef and islets (Eller to Ennylabegan). Four islets in this group have beaches suitable for nesting turtles but they are generally rather small and marginal, located on the lagoon side of the island. No turtle tracks were observed on any of these islands. A small cooling pond on Ennylabegan Island held two captive Green turtles that were evidently being raised by Marshallese inhabitatants living there. According to one of the Marshallese residents, no turtles presently nest on Ennylabegan.

21 June 1978

PODED-PV
SUBJECT: Trip Report 5-9 June 1978, Kwajalein Missle Range

(e) Kwajalein Island. Two Hawksbill turtles currently maintained in captivity in ponds on Kwajalein were positively identified and tagged with metal tags provided by Mr. George Balazs of HIMB. Carapace length and sex of each were recorded. Information on the origin of the turtles was provided by Mr. Mike May, member of the bachelor's club where one of the Hawksbill turtles and several Green turtles are kept. Neither Hawksbill was taken in Kwajalein. The turtle kept at the bachelor's club facility came from Likiap atoll via Ebeye. The other Hawksbill was imported from one of the other atolls in the Marshalls group. Both had been maintained in captivity for several years. The owners as well as the KMR Base Commander and other KMR administrative personnel were informed of the illegality of keeping Hawksbill turtles in captivity. We also informed the base Commander and the representatives of the Yokwe Yuk women's club regarding the illegality of selling Hawksbill turtle products in their airport store. Although a small note on the counter indicated that U.S. Customs prevented import of turtle products, they continued to sell rings made of Hawksbill turtle shells in the store. The women we spoke to at the store was aware of the regulations and stated that the turtle rings were part of a large shipment from Palau or Ponape that was received sight unseen. We informed Mr. Jim Baltee, FWS Inforcement Officer in Honolulu, about the turtles on our return and he indicated that he would correspond directly with the KMR Base Commander regarding the disposition of the captive Hawksbills and the sale of turtle products.

Robert Shallenberger
ROB SHALLENBERGER
Ecologist

Robert Moncrief
BOB MONCRIEF
Ecologist

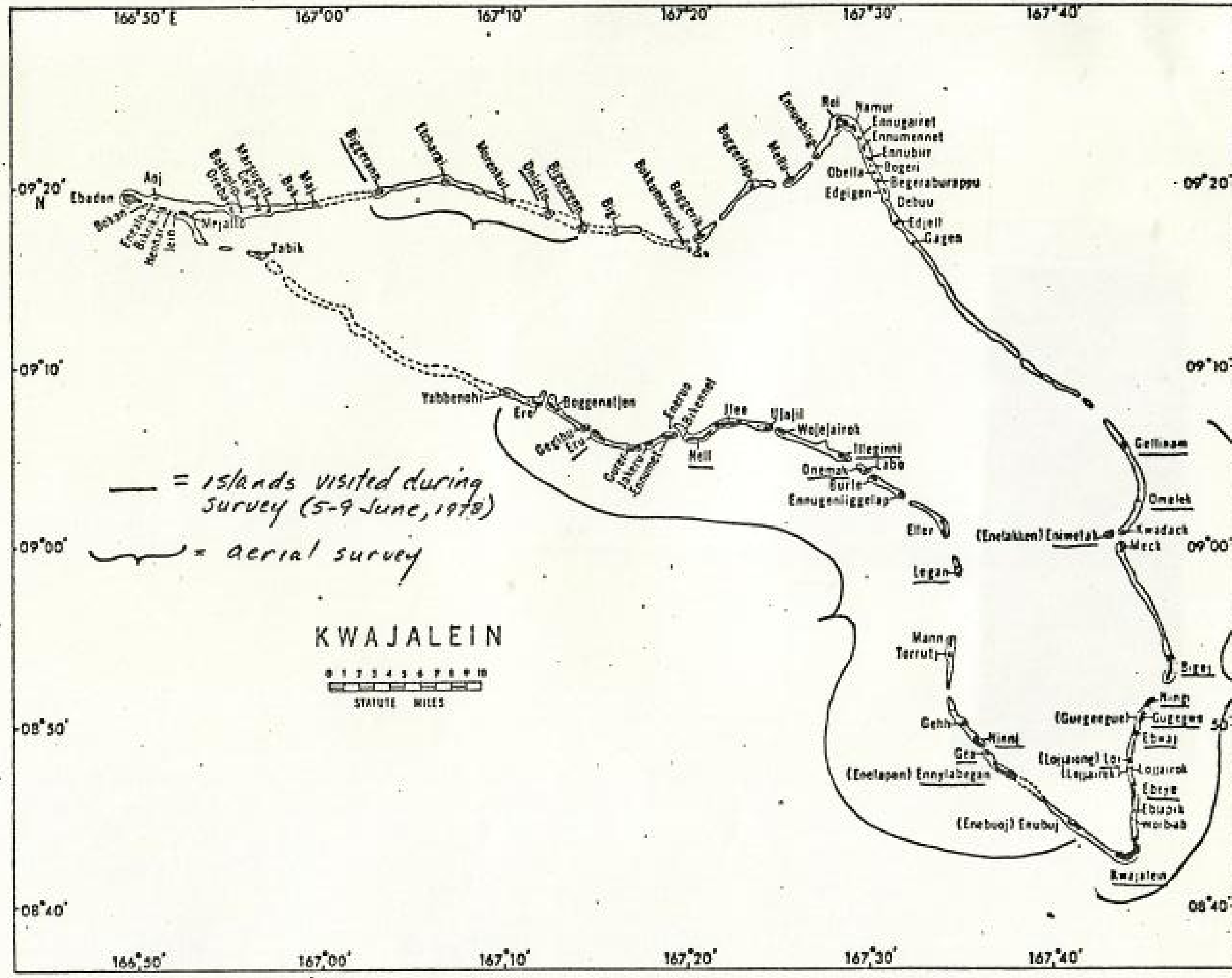
1 Incl
1. Map

CF:
C, Engrg Div
C, Const-Ops Div
District Engineer
Division Engineer

Hawksbill tagging info:

1. Female, Carapace length 72 cm
tag # 1326 (lge tag)
1894 (small tag)

2. Female (?), carapace length 46 cm
tag # 1895 (small tag)
large tag was not used due to small size of the turtle.


KWAJALEIN
STATUTE MILES
— = islands visited during survey (5-9 June, 1978)
= aerial survey
Ebadon
Roi
Namur
Kwajalein
Ebeye
Gellinam
Omelek
Meck
Legan
Illeginni
Bigej
166°50' E
167°00'
167°10'
167°20'
167°30'
167°40'
09°20' N
09°10'
09°00'
08°50'
08°40'
1718

NR 422
HIG DE HIMB
R 040049Z FEB 76
FROM BALAZS HIMB COCONUT ISLAND
TO LAMBERSON MPML ENEWETAK
INFO MPML LIST A
BT

WOULD APPRECIATE BEING BROUGHT UP TO DATE WITH RESPECT TO SEA TURTLE SITUATION AT ENEWETAK.
1) WHAT WAS THE OUTCOME OF APPARENT NESTING ON BIKEN ISLET LAST JUNE? WERE EITHER LIVE OR DEAD HATCHLINGS OBSERVED THAT PERMITTED POSITIVE SPECIES IDENTIFICATION?
2) HAVE YOU NOTED ANY OTHER INDICATIONS OF NESTING SINCE JUNE 1975?
3) HAS THE OPPORTUNITY ARISEN TO USE NUMBERED TAGS WHICH I PREVIOUSLY SUPPLIED
4) DO YOU NEZB MORE TURTLE SIGHTING FORMS?
5) ANY OTHER TURTLE OBSERVATIONS TO RELATE WHICH MAY BE INTERESTING?
I HOPE TO BE ABLE TO DO A PRELIMINARY TURTLE SURVEY OF THE ATOLL THIS SPRING. BEST REGARDS TO YOU AND JANET.
BT

THATS IT HOW COPIES
KKKKK
RGR
GSL YOUR NR 419 420 421 422
HAVE NOTHING HERE NOW
KK

RGR HAVE A GOOD DAY
SKSKSK
AND YOU TOO CUL UE

UNIVERSITY OF CALIFORNIA

San Diego

Neo-Tobian Culture: Modern Life on a Micronesian Atoll

A dissertation submitted in partial satisfaction of the requirements for the degree Doctor of Philosophy

in Anthropology

by

Peter Weston Black

Committee in charge:

Professor F. G. Bailey, Chairman
Professor Roy G. D'Andrade
Professor Donald Tuzin
Professor Randall Collins
Professor Harry N. Scheiber

1977

aimed at finding an alternative buyer for all the island's copra then it is called an idea to help the island, and falls into the chief's provenance.

Even problems assigned to natural and not human agencies have solutions proposed to them. The idea to help the island by adopting Vietnamese children is an example of an attempt to escape the consequences of recent demographic events. Other examples are not hard to find.

In view of the clinical picture of Western Carolinians from Ulithi and Truk as a people with no capacity to plan for the future (Lessa and Spiegelman 1954, and Gladwin and Sarason 1953) I shall present examples of two successfully implemented ideas to help the island.

> In recent years there has been a dramatic decrease in the number of turtles caught on the island. Turtles are a favorite food and during the turtle season people put a lot of effort into their capture. It is thought by the islanders that turtles return to lay their eggs on the same island where they themselves were hatched. (I do not know if this is traditional or new knowledge.) It was decided in a meeting that turtle eggs (a great delicacy) would no longer be eaten, so that in the future there would be more turtles to eat. A fine was established for anyone who violated the new ordinance. A person finding a nest of turtle eggs reports this to the magistrate who immediately fences the site to keep the eggs safe from hungry cats. When the eggs hatch, (the time can be predicted to within a day) the new born turtles are not allowed to make their dangerous trek across the beach and reef to the open sea. Much to the disappointment of the many birds who gather at the first sign of a hatching, the baby turtles are

> gathered up and kept in a large bucket for a week. They are fed fine-chopped fish and it is only when they are thought big enough to have a good chance for survival that they are ferried by canoe out to the open sea and released. This program was newly inaugurated when I first visited the island and was being faithfully carried out. By the time I returned three years later the ban on eating eggs, although still in effect, was not being observed by the new crop of adolescent boys who had not been in on the initial decision. They were now steathily eating all the eggs they could find. This failure is, one should note, a failure to maintain compliance and not a failure to plan for the future.[39]

The second example has enjoyed greater success in its implementation, due no doubt to its drastic nature.

> Some years ago many people kept dogs on the island. Some of the dogs, so the story goes, were extremely well trained and helped their owners in many ways. Others had become wild and lived in the bush, eating rats and feral chickens. The dog population steadily increased and eventually the dogs became a problem. Children were being bitten, chicken flocks being raided and cats being killed. Nights of full moon became intolerable, so the story goes, as packs of dogs raced up and down the village path, howling, barking, and fighting. Eventually a meeting was called by the magistrate to propose a solution. The meeting, which took place on a Sunday, agreed to give dog owners until the following Wednesday to get rid of their dogs. On that day the magistrate and some of the young men would go dog hunting with the municiple rifle, and dispatch any dog they could find. The chief was the first to kill his (so it is said) much loved pet. Most other people followed suit. One old woman could not bring herself to kill her pet and begged the young men to let it live but her pleas were not heeded. The following Wednesday a general slaughter of dogs took place. When it was over only one dog was left alive on the island. It belonged to the mistress of one of the most powerful

FCDNA INTERIM QUARANTINE FOR RUNIT ISLAND

1. Scope. Unauthorized entry upon Runit Island, Enewetak Atoll, Marshall Islands, Trust Territory of the Pacific Islands, is prohibited. This prohibition is made necessary by the presence of hazardous quantities of the element plutonium in certain areas of Runit Island.

2. Violations and penalties. Whoever willfully violates the quarantine defined herein is subject to immediate removal from and denial of future access to Enewetak Atoll, as well as possible subsequent disciplinary action.

3. Responsibilities. The Commanding Officer, Enewetak, is responsible for advising all persons requesting approval for access to Enewetak Atoll that this quarantine is in effect.

4. Access. Permission for entry upon Runit Island may be granted by the Commanding Officer, Enewetak Atoll only for conducting official business and when conditions warrant the accepting of risks inherent with such an entry. Unnecessary exposures to nuclear radiation should be avoided always, and there should not be any exposure without the expectations of benefit resulting from the exposure. For those persons who are granted permission to enter upon Runit Island, the sole entry/exit point will be the existing pier on the lagoon-side of the Island, (unless otherwise authorized by the Commander, Enewetak) and suitable precautions as listed in paragraph 5 below will be obeyed.

5. Procedures. Any person authorized to enter upon Runit Island will obey reasonable safety precautions to mitigate the possibility of radiation exposure and the removal of radioactive material from the Island. The following procedures include only minimum safety precautions to be observed:

a. Surgical masks and boots will be worn at all times while on Runit Island unless otherwise advised by a Radiation Safety Officer. A supply of these safety items will be maintained and furnished by the Enewetak Atoll Operating Contractor.

b. Used (and possibly contaminated) protective gear will be deposited in a designated container located near the Runit Island exit point. The Enewetak Atoll Operating Contractor will furnish large plastic trashbags for collecting contaminated debris, and a 55-gallon drum for containing the trashbags. The collected debris will be retained on Runit Island for ultimate disposal as part of the Enewetak Atoll cleanup.

c. Any eating, drinking or smoking while on Runit Island will be confined to the entry/exit points.

d. No materials on Runit, including Flora and Fauna may be handled by bare hand.

e. Any incident resulting in wounds, abrasions, or cuts will be immediately reported to the Commanding Officer, Enewetak Atoll for further advice.

f. No item will be collected for removal from Runit Island without specific approval from a Radiation Safety Officer who is knowledgeable of the hazards on Runit Island.

6. Records. A record will be maintained to include name and organization of any person authorized entry upon Runit Island, dates and times the person is on the Island, a brief explanation of the purpose of the visit and any dosimetry results which are obtained. Any unusual incidents will be duly noted in the record. A copy of the record will be maintained at Enewetak by the operating Contractor.

Need Solicitors opinion

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SOLICITOR
WASHINGTON, D.C. 20240

10 JUL 1975

RD 0
DRO Wilson
AAD-H
SE
LE

Memorandum

To: Associate Director, Federal Assistance
Fish and Wildlife Service

From: Associate Solicitor, Conservation and Wildlife

Subject: Applicability of Endangered Species Act of 1973 to the Trust Territory of the Pacific Islands and American Samoa

In response to your request of May 2, 1975, for an opinion on numerous issues under the Endangered Species Act of 1973 (16 U.S.C.A. §1531, et seq.) (hereinafter cited as the Act), we submit the following information. One caveat is in order concerning the legal analysis on the Trust Territory. In the middle of June, a plebiscite was held in the Trust Territory which determined that the inhabitants of the Northern Mariana Islands desired to join the United States as a territory. However, the actual achievement of this status is still a few years off. In addition, the Interior Department is engaged in negotiations on the future political status for the rest of Micronesia. Because of the uncertainties created by the election on territorial status and these negotiations, certain parts of this opinion could be rendered inoperative. For example, the legal system founded upon the Trusteeship Agreement with the United Nations could be significantly altered. Therefore, any analysis based upon the Territorial Code or the Trusteeship Agreement would have to be reevaluated for the Northern Mariana Islands, and perhaps eventually, for the remainder of the Trust Territory.

I. Does the Act in its Entirety Apply to the Trust Territory

The Trust Territory of the Pacific Islands (T.T.P.I.) is not a territory of the United States over which Congress exercises

cc: SH, Honolulu, HI

U.S. FISH & WILDLIFE SERVICE
RECEIVED
JUL 28 1975
HONOLULU
Hawaii Area Office

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

sovereign control pursuant to Article IV, Section 3, Clause 2 of the Constitution. As its name signifies, it is a trust territory administered by the United States under the authority of the Trusteeship Agreement between the United States and the Security Council of the United Nations. (61 Stat. 3301) (approved by Joint Resolution July 18, 1947, 61 Stat. 397). In particular, Article III of the Trusteeship Agreement authorized the United States to include the Trust Territory within the coverage of those federal laws which the United States considered appropriate, in view of local conditions and requirements. This is not a self-executing provision of the treaty. It must be implemented by a positive act of the U. S. Congress extending a particular law to the TTPI.

It is our legal conclusion that the Endangered Species Act is such a law that Congress intended to apply to the TTPI. Section 3(12) of the Act (16 U.S.C.A. §1532(12)) specifically includes the Trust Territory within the definition of a "state." Section 3(16), (16 U.S.C.A. §1532(16)) defines the "United States" when used in a geographical context to "include all of the States." Therefore, the Trust Territory is included within the key definitions defining the geographical scope of the Act. Since there is no evidence to indicate that Congress intended only certain provisions of the Endangered Species Act to apply, the Act in its entirety should be deemed applicable to the Trust Territory.

II. Are Residents of American Samoa and the Trust Territory Subject to Apprehension and Prosecution for Violation of the Endangered Species Act?

The prohibitions of the Endangered Species Act set forth in section 9 (16 U.S.C.A. §1538) are made applicable to "any person subject to the jurisdiction of the United States." The definitions of "United States" and "state" in section 3 of the Act specifically include, among others, American Samoa and the TTPI. Accordingly, the prohibitions of the Act are applicable to residents of those two areas regardless of whether or not they are citizens of the U.S.

It should be noted that the applicability of the Act's proscriptions to American Samoans is further buttressed by the express direction in section 11(c) (16 U.S.C.A. §1540) that for enforcement purposes,

the United States District Court for Hawaii would have jurisdiction over violations arising in American Samoa.

III. What Courts have the Appropriate Jurisdiction for Enforcing the Provisions of this Act?

Section 11(c) of the Act specifically directs that for purposes of enforcement in American Samoa, the United States District Court for Hawaii shall have jurisdiction for all civil or criminal actions arising under the Act. This section is silent, however, as to proper jurisdiction for actions arising in the Trust Territory. A more detailed analysis is therefore necessary to resolve this issue.

It has been previously noted that Article III of the Trusteeship Agreement authorizes the United States to apply certain of its laws to the Trust Territory and that the Endangered Species Act of 1973 was just such a law. As a corollary to Article III, section 101 of Title 1 of the Trust Territory Code states:

> §101 Additional Laws Applicable to Trust Territory. The following are declared to be in full force and to have the effect of law in the Trust Territory of the Pacific Islands:
>
> (2) such laws of the United States, as shall, by their own force, be in effect in the Trust Territory. . . .

This section has been interpreted in a memorandum of April 5, 1974, from the Assistant Solicitor, Territories, to the Chief Counsel of the Coast Guard, to mean that those laws of the United States applicable to the Trust Territory, in effect become laws of the Trust Territory itself, and as such, are capable of enforcement in the court system of the Trust Territory.

One caveat should be noted at this point. Declaring that an applicable law of the United States becomes the law of the Trust Territory under section 101 of the Territorial Code, does not mean

that the entire statute, replete with administrative obligations and responsibilities, is transfered into the statutory framework of the Territory. That is, in the case of the memorandum of April 5, 1974, to the Coast Guard, the Trust Territory Government would not supplant the Coast Guard in its administrative responsibilities under the various statutes in question. Thus, while the enforcement provisions of "applicable statutes" become part of the Trust Territory Code via section 101 (violations of which would be punishable in the local courts), the administrative responsibilities under those statutes do not become so incorporated. The "High Commissioner" of the Trust Territory could not be substituted for the Secretaries of "Interior" or "Commerce" under the Endangered Species Act of 1973.

One option for an enforcement official, therefore, would be to turn over the evidence of a violation of the Endangered Species Act of 1973 to the Attorney General of the Trust Territory to prosecute the accused for a violation of "Territorial Law." This unusual arrangement appears to be possible because of the unique political position of the Trust Territory.

The only other present alternative to prosecuting violations of the Act as violations of "Territorial law," is to charge the accused with a violation of federal law. This alternative has some serious limitations, however, since the Trust Territory is not located in any federal judicial district of the United States. If federal criminal charges were to be brought, 18 U.S.C. §3238 would have to provide the basis for proper venue for the action:

18 USC Sec 3238

Power to prosecute in first found in Hawaii. (Penalty)

> The trial of all offenses begun or committed upon the high seas, or elsewhere out of the jurisdiction of any particular state or district, shall be in the district in which the offender, or any one of two or more joint offender, is first brought; . . .". (Emphasis added.)

In the case of an offense committed in the Trust Territory, the United States federal district courts in Hawaii or Guam would represent the nearest and most convenient districts to take the

accused. The inherent disadvantage to this arrangement is that in some cases, the accused party may have to be brought thousands of miles across the Pacific Ocean to reach Hawaii or Gaum. Furthermore, it appears to be rather questionable whether 18 U.S.C. §3238 could be applied to a resident of the Trust Territory because of the fact that in legal contemplation, it is considered a foreign country (See, Callas v. U.S., 253 F.2d 838 (1958); Brunell v. U.S., 77 F. Supp. 68 (1948)), and its natives are neither citizens nor nationals of the United States. They are citizens of Micronesia.

A more significant problem would arise if the civil penalty provisions of the Act were utilized. Logistically, it could be quite an expensive matter to send an administrative law judge out to the Trust Territory to assess the civil penalty. But more importantly, it is highly unlikely that subpeonas, directing the accused or necessary witnesses to appear to testify or to produce relevant documents could be enforced. Section 11(a)(2) of the Act states that upon refusal to obey a subpeona issued for a civil hearing, the district court of the United States "for any district in which such person is found or resides or transacts business" shall have jurisdiction to issue an order compelling compliance with the subpeona. No district court would qualify for venue over the matter under the statute, if the subpeonaed resident of the Trust Territory remained at home and conducted only local business.

The same problem arises if the accused refuses to pay, once a civil penalty has been assessed. No federal district court would present proper venue under section 11(a)(1) of the Act to hear a civil action to collect the penalty.

Resort to the general venue provisions in Title 28 of the United States Code provides no additional help in collecting a civil penalty. Section 1395(a) of Title 28 states that, "a civil proceeding for the recovery of a pecuniary fine, penalty, or forfeiture may be prosecuted in the district where it accrues or the defendant is found." Again, no federal district court would qualify under that provision.

The eventual solution to this enforcement dilemma appears to rest in the approval of a cooperative agreement under section 6 of the Act. Once the Territorial officials receive the necessary authority for a cooperative agreement from the Congress of Micronesia, the most legally viable enforcement program would be to let them handle violations of the Act under the express provisions of their own endangered species legislation, rather than having them prosecute offenders on the basis of the convoluted theory of "incorporation" via section 101 of Title I of the Territorial Code.

IV. Enforcement Authority of a Territorial Conservation Officer or a Service Special Agent

Because the entire Endangered Species Act applies to the Trust Territory and American Samoa, the enforcement provisions of section 11 (16 U.S.C.A. §1540) delineates the powers of the various law enforcement officials in those areas. A Service special agent authorized to enforce the Endangered Species Act, therefore, would have the same enforcement powers in the Trust Territory and American Samoa as he would have in the continental United States.

A Territorial conservation officer would have to rely upon the provisions of section 11(e) for enforcement authority. Section 11 (e) states that the Act shall be enforced by the Secretary and authorizes him to utilize by agreement, the personnel and facilities of other "state" and federal agencies for enforcement purposes. If the Fish and Wildlife Service entered into an appropriate enforcement agreement with the Trust Territory under section 11(e), Territorial game officers could be designated as enforcement officers for purposes of the Act, capable of exercising the various enforcement powers set forth therein.

In addition, once the Congress of Micronesia passes sufficient legislation implementing their own endangered species program, the Territorial game officials could enforce the Act under a section 6 cooperative agreement.

see attached June 25 4 pages.

V. What is the Applicability of the Various Treaties and Conventions Set Forth in Section 1 to the Trust Territory, American Samoa, and Guam?

The Solicitor's Office has been informed by the Treaty Affairs Division of the General Legal Advisor's Office at the State Department that when the United States enters into a unilateral or bilateral agreement with other nations, there is a presumption that it will extend to the territories and possessions of the United States and the Trust Territory, if applicable to local conditions. 14 Whiteman, DIGEST OF INTERNATIONAL LAW, at 49-50 (1963-71); see also Article XIV of the United Nations' Trusteeship Agreement. The State Department further indicated that the fact that treaty commitments were negotiated prior to the acquisition of jurisdiction or control over a territory or possession, does not necessarily prevent the treaty's application to that area.

This general attitude of the State Department is important for answering the inquiries in Question V, because rarely in treaties or conventions is a definition of the "United States" included. In reliance upon this assertion, it is our opinion that the treaties and conventions listed in section 1 apply to American Samoa and the TTPI with the exception of those that would be locally inapplicable (the International Convention on Northwest Atlantic Fisheries or the Canadian Migratory Bird Treaty, for example).

Due to the unique character of its Organic Act, not all of these same conventions and treaties would apply to Guam. By memorandum of January 10, 1969, the Assistant Solicitor for Fish and Wildlife indicated that the Migratory Bird Treaty Act was inapplicable to Guam, as evidenced by the report of the COMMISSION ON THE APPLICATION OF FEDERAL LAWS TO GUAM, H.R. Doc. No. 212, 82d Cong., 1st Sess. 29 (1952), prepared in compliance with Section 25(b) of the Organic Act of Guam. (48 U.S.C. §1421(c)(b)). It is logical that if the Migratory Bird Treaty Act did not apply to Guam, neither did the Act's underlying Treaties with Mexico or Canada. The Migratory Bird Treaty with Japan in 1974, however, was negotiated subsequent to the Commission's report of 1952 and specifically concerned the migratory birds of the Pacific area. The Migratory Bird Treaty Act was again amended to

"LACEY ACT" APPLIES - GUAM
Endangered Species Act

take into account this treaty with Japan (88 Stat. 190). Though the conclusion of the memorandum of January 10, 1969 (that the Migratory Bird Treaty Act was inapplicable to Guam) must now be abandoned due to the Japanese Treaty amendments, its implied position that the migratory bird treaties with Canada and Mexico were also inapplicable, retains its validity. The Commission's report of 1952 rejected the Migratory Bird Treaty Act for Guam because local conditions made the terms of the Canadian and Mexican Treaties inappropriate. Those local conditions still exist with respect to those two treaties. The International Convention on Northwest Atlantic Fisheries would also be inapplicable to this area due to the "local conditions" rule.

VI. How are the Matching Funds Provisions of the Act to be Applied to the Trust Territory and American Samoa?

There is no basis for concluding that the Trust Territory and American Samoa are free of the requirements of providing 33 1/3 percent of the funds for an endangered species conservation program under section 6(d) of the Act (16 U.S.C.A. §1535(d)). Whether the Trust Territory and American Samoa have to derive their 33 1/3 percent share from entirely local revenues can be answered by referring to long standing administrative interpreptations of similar funding statutes.

Funds appropriated to the Department of the Interior for the administration of the Trust Territory are granted to the local government and are commingled with local revenues, losing their identity as federal funds. In a memorandum of June 18, 1968, the Assistant Solicitor for the Branch of Territories approved the use of these commingled administrative funds to match the federal funds offered under the Partnership for Health Amendments Act of 1967 (81 Stat. 533). The memorandum inferred that Congress was aware of the fiscal situation of the Trust Territory and stated that the amount of revenue generated from purely local sources was insignificant indeed. The memorandum concluded that by expressly including the Trust Territory within the program for grants under the 1967 Act, Congress indicated that the Trust Territory was not required to match the available federal funds out of strictly local revenues. A contrary conclusion would have rendered the Trust Territory's participation in the program practically meaningless, a result not to be attributed to Congressional intent.

While the Trust Territory has been allowed to use commingled administrative grant funds for matching grant programs, the policy for American Samoa has been the reverse. By memorandum of March 3, 1972, the Associate Solicitor for Territories, Wildlife and Claims indicated that an agreement had been reached in July of 1969 between the Governor of American Samoa and the Chairwoman of the House Appropriation Subcommittee on Interior and Related Agencies, restricting severely the use of administrative grant funds as matching funds for federal grant programs. While there appears to be no legal authority compelling this prohibition, we have been informed that the Office of Territorial Affairs as a rule still abides by its terms. American Samoa, therefore, would have to obtain its 33 1/3 percent matching share from entirely local revenues.

LACEY ACT - APPLIES - Somoa also has the ENDANGERED SPECIES ACT.

CODE OF THE

TRUST TERRITORY

of the

PACIFIC ISLANDS

Supplement No. 1

Volume I

[Containing all of the laws of a general and permanent nature that were enacted in 1971 and 1972 by the government of the Trust Territory of the Pacific Islands.]

BOOK PUBLISHING COMPANY
SEATTLE, WASHINGTON

kill fish or marine life, nor shall any person knowingly possess or sell any fish or any other marine life caught by means of explosives, poisons, chemicals, or other substances which kill fish or marine life. The terms "poisons", "chemicals", or "substances" include but are not limited to hypochlorus acid or any of its salts, including bleaches commonly sold under various trade names, such as Clorox and Purex, and bleaching powders, preparations containing rotenone, tephrosin or plant material from Barringtonasiatica, Coculus ferrandianus, Hura crepitans, Piscidia erythrina, Tephrosia purpurea, and Wikstremia.

(b) Except as provided in Subsection (2) of this Section, no person shall knowingly place or cause to be placed, in any waters of the Trust Territory, explosives, poisons, chemicals, or other substances with the intent to kill fish or other marine life.

(2) The provisions of Subsection (1) of this Section shall not apply where the District Administrator:

(a) has granted written permission to use the means prohibited in Subsection (1), or

(b) has determined that the

(i) purpose of obtaining the fish or other marine life is to avoid the waste or loss of such fish or marine life; and

(ii) consumption or sale of fish or other marine life caught by any means the use of which is prohibited in Subsection (1), is not harmful or hazardous to health and human life.

(3) Nothing in this Section shall be construed to prevent any person from catching any fish or other marine life by the use of local roots, nuts, or plants which have the effect of stupeyfying but which do not kill fish or other marine life.

(4) Any person who violates any of the provisions of this Section shall, upon conviction thereof, be fined not less than one hundred dollars or more than two thousand dollars, or imprisoned for not less than six months or more than two years, or both.

1. The Committee on the Code renumbered the paragraphs of §§ 1—4 of P.L. 4C-35 to be Subsections (1)—(4) of 45 TTC § 1.

Editor's Note: The former 45 TTC § 1 was repealed by P.L. 4C-35, § 5. The present 45 TTC § 1 was added by P.L. 4C-35, §§ 1—4. Effective date—April 1, 1972.

§ 2. Limitations on taking of turtles.

(1) No hawksbill turtles or sea turtles shall be taken or intentionally killed while on shore, nor shall their eggs be taken.

(2) No hawksbill turtle shall be taken or killed except whose shell is at least twenty-seven (27) inches when measured over the top of the carapace shell lengthwise; no green turtle shall be taken or killed except whose shell is at least thirty-four (34) inches when measured over the top of the carapace shell lengthwise.

(3) No set turtle of any size shall be taken or killed from the first day of June to the thirty-first day of August inclusive, nor from the first day of December to the thirty-first day of January inclusive.

(4) Notwithstanding any provisions of this Section to the contrary, taking of sea turtles and their eggs shall be allowed for scientific purposes when specifically authorized by the High Commissioner.

Editor's Note: Amended by P.L. 4C-57, §§ 1—3. Effective date—April 13, 1972.

P.C. 4C-57 repealed former subsections (2) and (3) and added the present text of subsections (2), (3) and (4).

NOTES

The provisions of the Code relating to the taking of turtles contains no specific indication of any territorial limit and is binding upon all Trust Territory citizens, residents, and any others subject to Trust Territory jurisdiction, regardless of the location of the party or act. Kodang v Trust Territory, 5 TTR 581 (1971).

§ 4. Control of pinctada margaritifera (black-lip mother-of-pearl oyster shell). No pinctada margaritifera, commonly known as black-lip mother-of-pearl oyster shell, shall be taken from the first day of August to the thirty-first day of December inclusive; PROVIDED, that no such shell may be taken at any time which is less than four inches in minimum diameter as measured across the nacre; and PROVIDED FURTHER, that such shells, of any size, may be taken at any time for scientific purposes when specifically authorized by the High Commissioner.

Editor's Note: Amended by P.L. 4C-57, § 4. Effective date—April 13, 1972.

The 1972 amendment rewrote the section.

§ 5. Penalties. A person violating any of the provisions of this Title for which a different penalty is not otherwise provided

RESEARCH PROPOSAL

MID-PACIFIC MARINE LABORATORY
ENEWETAK ATOLL, MARSHALL ISLANDS

Date September 27, 1976

Name of Principal Investigator George H. Balazs

Social Security No. 564-54-0156 Date and place of birth 2-26-43 Detroit, Michigan

Academic or research title and affiliation (if graduate student, provide the name of your professor) Jr. Marine Biologist, Hawaii Institute of Marine Biology

Address P. O. Box 1346, Kaneohe, HI

Telephone No.: 247-6631

Co-investigators and assistants (Indicate graduate and/or undergraduate status if students)

Dates you desire to carry out your investigations at MPML (facilities are open year-round). Indicate seasonal, lunar, or other chronological considerations necessary.

October 12 - 20, 1976

Have you ever been to MPML (EMBL)? No If so, when?

Is the research proposed a continuation of previous work done there? No

Short title of proposed research Preliminary investigation of the status and survival outlook of marine turtles at Enewetak Atoll.

PLEASE RETURN ONE ORIGINAL AND THREE XEROX COPIES OF PROPOSAL.

Principal scientific objective(s) of proposed research (in outline form). Be specific as to what hypotheses you are testing and/or expected accomplishments.

1. To determine the distribution and abundance by size categories of marine turtle species occurring at Enewetak Atoll.
2. To ascertain the locations, extent, and seasonality of marine turtle reproduction at Enewetak Atoll.
3. To obtain information on the movements of marine turtles from Enewetak Atoll to other Pacific locations.
4. To further the long-term conservation and wise utilization of marine turtles at Enewetak Atoll by developing a better understanding of the Trust Territory Code, the U.S. Endangered Species Act, and the guidelines of the International Union for Conservation of Nature (IUCN).

In what way is MPML particularly suited for your research?

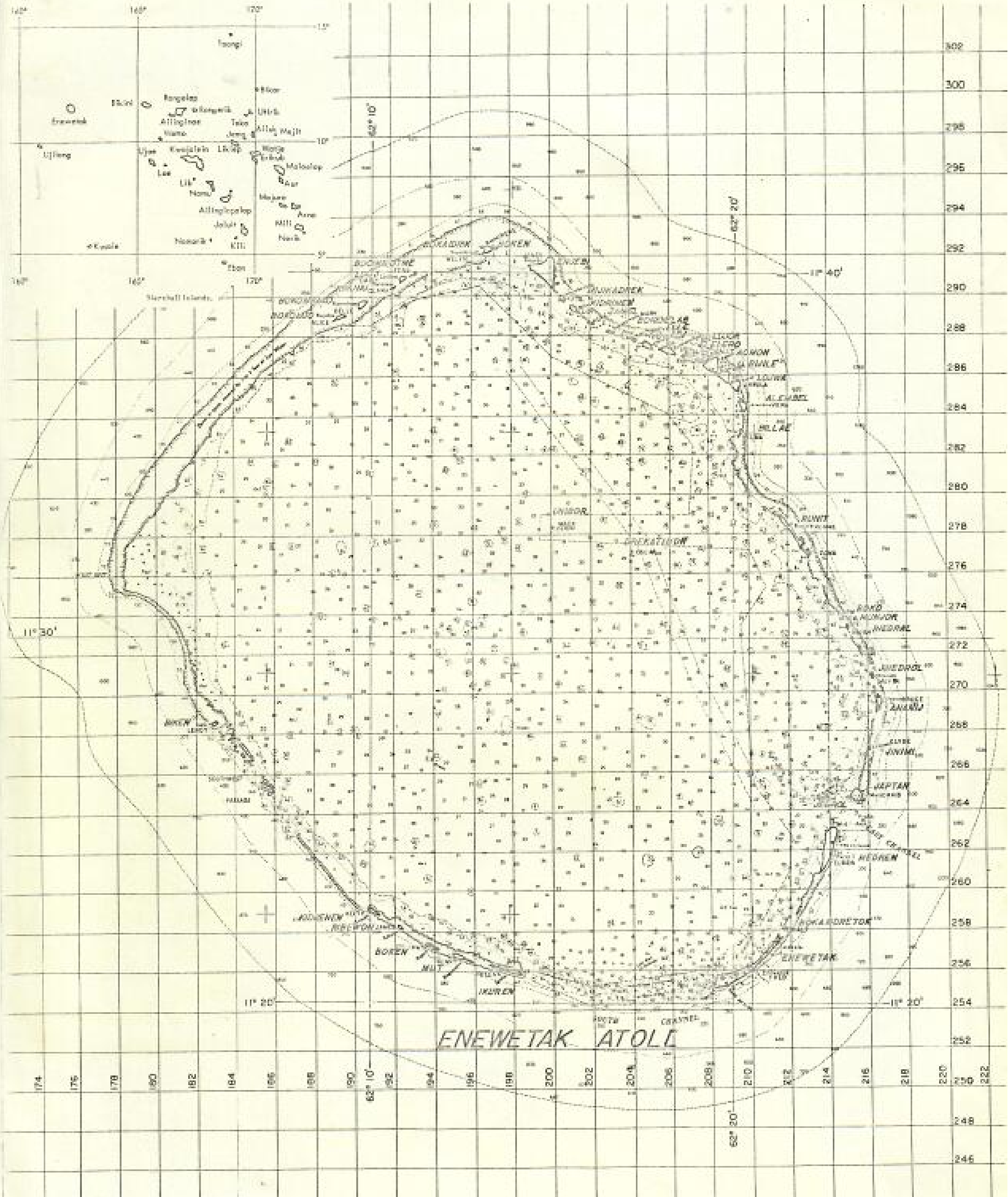
MPML offers ready accessibility to populations of marine turtles that have thus far not been comprehensively examined with respect to status and survival outlook.

Scientific description and justification of proposed research (including relevant references). Continue on extra pages if necessary.

Very little basic biological information exists on the marine turtles of Enewetak Atoll. Such data are essential in view of the endangered status of the majority of the world's marine turtle populations.

In October of 1974 I set out to collect information on Enewetak's marine turtles through the use of turtle sighting report forms made available to residents and visitors. In addition, permanent identification tags were supplied to the MPML manager for application to turtles captured incidental to other research activities. A point has now been reached in this preliminary work where it is necessary for me to personally conduct a reconnaissance survey of the atoll if further progress is to be made.

Research activities will principally involve in-water examinations and taggings at select locations based on compiled sighting reports. Additionally, land surveys will be made on as many islands as conditions and time permit. Meetings will be held with interested resident personnel in order to discuss marine turtle conservation problems and stimulate interest in an ongoing intensive tagging program.



ENEWETAK ATOLL
Marshall Islands
Enewetak
Ujelang
Bikini
Rongelap
Rongerik
Ailinginae
Wotho
Ujae
Kwajalein
Lae
Lib
Namu
Ailinglapalap
Jaluit
Namorik
Kili
Ebon
Kusaie
Taongi
Bikar
Utirik
Taka
Jemo
Ailuk
Mejit
Likiep
Wotje
Erikub
Maloelap
Aur
Majuro
Arno
Mili
Knox
BOKAIDRIK
JAPTAN
ENEWETAK
MEDREN
BIKEN
ANANIJ
JINIMI
RUNIT
LUJOR
IKUREN
MUT
BOKEN
SOUTH CHANNEL
11° 40'
11° 30'
11° 20'
62° 10'
62° 20'

The houses are ready for the Bikinians but the land's too hot.

Bikini, a home too hot for its people

From MIKE MALONE at Saipan

The displaced people of Bikini Atoll, in the Marshall Islands, removed from their home islands almost 30 years ago to make way for nuclear testing by the United States did not go home in September as planned—their homeland is still "hot".

A postponement was officially announced by the US Department of Interior so that "analysis and evaluation of the latest radiological survey" could be completed. But a preliminary US government report in August warned that foods grown on Bikini are unsafe for human consumption and "should not be eaten".

The survey, taken in June by the Energy Research and Development Administration (formerly Atomic Energy Commission) revealed gamma ray exposure rates "considerably higher" than on neighbouring islets that surround Bikini's 200-ft deep lagoon, where a fleet of ships sunk in the 1946 tests still lie.

And, despite an extensive $US4 million clean-up, rehabilitation and agricultural replanting programme undertaken on Bikini since 1968, including construction of 40 concrete houses and community buildings, the report said Bikini "should be considered of limited use".

After Bikini was declared "safe" by the Atomic Energy Commission in 1967, President Johnson pledged to return the Bikini people as soon as a massive clean-up programme was completed. Moon-like craters were filled in, and over 40,000 trees, mainly coconut, planted in neat rows on the atoll's two principal islands, Bikini and Enyu.

Interior Department officials called the former nuclear test site "the best planted island in the Pacific" and enthusiastically described Bikini as a future "showcase island".

The results of the latest unpublicised report, however, said no more homes should be built on Bikini, but instead on nearby Enyu, four miles away, where radioactive levels are lower. Fish, birds, bird eggs, and coconuts were declared safe to eat, but the report said final analysis of the June survey might not be available until early 1976.

Bikini, part of the Trust Territory, has been administered by the United States since taken from Japan in World War II.

Early in 1946, Bikinians were persuaded by the US Navy to leave their atoll for what they believed would be a short time. Taking only what personal belongings they could carry, the islanders were moved to isolated Rongerik, an uninhabited atoll islanders say possesses many poisonous fish.

The Bikini people nearly starved.

In 1948, they were evacuated to a "tent city" on Kwajalein, then a navy base; today a top-secret missile testing range for the US Army. Eight months later, the Bikinians were moved to a tiny, uninhabited island called Kili, which is one-seventh the size of Bikini. Lacking a lagoon and adequate farmland, food on Kili has

Ataji Balos . . . we have the trust, the Americans have the territory.

been air-dropped by military aircraft from Kwajalein.

Today, the gentle Bikini islanders speak of their former homeland with a strange mixture of nostalgia for the old days and resentment of the United States' treatment during nearly three decades of exile.

Many of the old people still hope they will be laid to rest near their ancestors. The young, on the other hand, have never seen this place called Bikini, which their elders speak so fondly of.

Adverse world opinion prompted the US Government to set up a $300,000 trust fund in 1956 so the islands could receive an annual dividend. But, in 1973, Bikinians filed a lawsuit against the Trust Territory Government because the fund had diminished by over one-third.

The Bikini people's representative in the territory's national legislature, Ataji Balos, led a delegation of Bikini leaders to Washington last year demanding $3 million in compensation for their long years of hardship. The *ex gratia* payment was recently authorised by the US Congress.

Balos, a member of the Congress of Micronesia, has grown accustomed to dealing with Americans over the years and has championed the causes of other displaced islanders in his constituency, including Kwajalein and Eniwetak atolls. On Kwajalein, displaced Marshallese live in a 63-acre ghetto while their islands serve as a target-range for incoming missiles launched from Vandenberg Air Force Base, in California.

Like the Bikini people, the displaced people of Eniwetak also saw their islands turned into a nuclear test site and for years have demanded to be returned home.

Calm and soft-spoken, Balos summarised America's treatment of the Marshall Islands people as part of the vast Pacific Trust Territory:

"We islanders have the 'trust'; the Americans have the 'territory'."

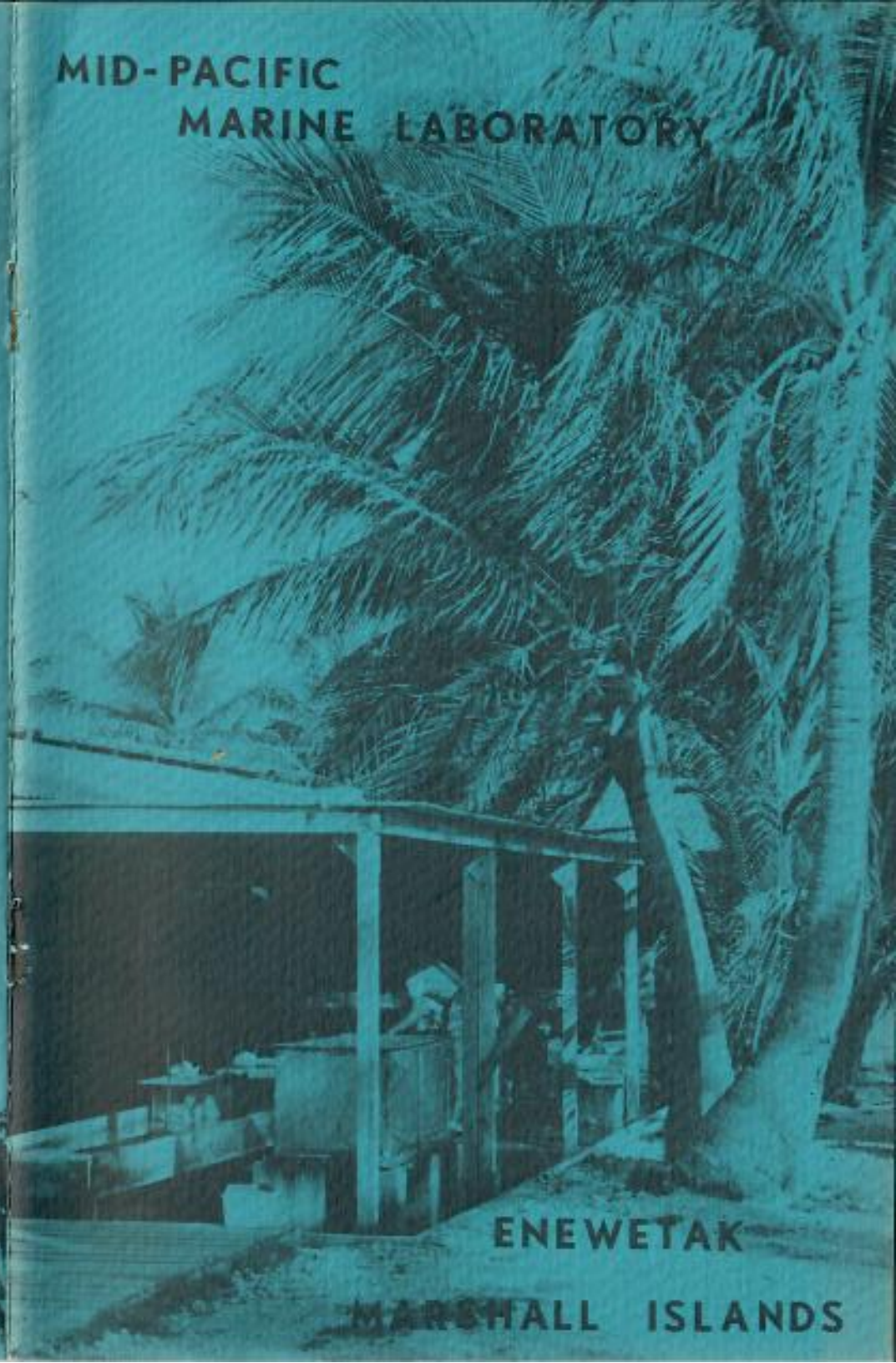
An attorney for the Bikini people, Theodore Mitchell of the Micronesian Legal Services Corporation, described the postponement as "doubly tragic". He said that all US government agencies involved have "utterly failed to carry out President Johnson's promise of 1968", and specifically blamed the Atomic Energy Commission for failing to gather adequate radiological data long ago to make sure Bikini would be safe for resettlement today.

Now after nearly 30 years of waiting, the Bikini exiles are being told they must wait again.

● The leaders and owners of Roi-Namur, an island in Kwajalein atoll, Marshall Islands, have filed a suit in the US Court of Claims, Washington, for $10 million, for the alleged "unlawful and uncompensated taking and continued use" of the island. The plaintiffs also claim damages for relocation and dislocation expenses.

MID-PACIFIC MARINE LABORATORY
P. O. Box 1346
Kaneohe, Hawaii 96744

MID-PACIFIC MARINE LABORATORY



ENEWETAK

MARSHALL ISLANDS

MID-PACIFIC

MARINE LABORATORY

OFFICES

Director
Mid-Pacific Marine Laboratory
Box 1346, Kaneohe, Hawaii 96744

Mid-Pacific Marine Laboratory
Enewetak, Marshall Islands 96737

CONTENTS

The Division of Biomedical and Environmental Research of the U. S. Energy Research and Development Administration (ERDA) supports the operation of the Mid-Pacific Marine Laboratory (MPML) at Enewetak Atoll. The laboratory is operated as an extension of the Hawaii Institute of Marine Biology of the University of Hawaii with the Research Corporation of the University of Hawaii handling internal management support services. The laboratory provides access to coral-atoll research facilities in the northern Marshall Islands.

MID-PACIFIC MARINE LABORATORY

The laboratory, formerly the Eniwetok Marine Biological Laboratory, has recently been reorganized and expanded into a year-round operation, with special emphasis on programs related to the distribution of radionuclides and other materials in an atoll ecosystem, the cycling of materials through such a system, and the possible implications of these

processes to man. This brochure provides prospective investigators at MPML with a brief look at the laboratory and its environmental setting.

PHYSICAL SETTING

Enewetak Atoll is located in the northwestern Marshall Islands (11° 30' N, 162° 15' E.) 1000 km south-southwest of Wake Island and 4400 km west-southwest of Honolulu, Hawaii.

A portion of Enewetak Atoll

Over the years, there has been some confusion in the name of the atoll and its islands. The name Eniwetok Atoll was sanctioned by the Board of Geographical Names in 1944. In 1972, when the people who had lived on the atoll until 1947 requested that they be allowed to return to their atoll, it was

determined that the atoll's name was more properly spelled "Enewetak", apparently from the words "ene" (island) and "wetak" (pointing toward the east). In deference to the Enewetak people, it has become the policy of ERDA and MPML to adopt this spelling and the native names for the various islands (see map on pages 12-13). Visitors to Enewetak will undoubtedly encounter at least three sets of names: the presently accepted Enewetak names, the version of these names sanctioned by the Board of Geographical Names, and the alphabetical "site designations" used by various military operations on the atoll. After some initial confusion, investigators adapt to this multiplicity of names!

Enewetak Atoll consists of approximately 40 islands on an elliptically shaped reef approximately 40 x 30 km surrounding a lagoon with a maximum depth of about 65 meters and area of 930 km^2. The total land area is about 7 sq. km, averaging 3 meters above sea level. Three channels, the deepest with a maximum depth of 57 meters, cut through the rim of the atoll to the open ocean. A limestone cap approximately 1 km thick overlies a pre-tertiary basaltic base that rises 4500 meters from the surrounding ocean floor. The relatively constant northeast trade-winds probably exert a significant influence in the formation of the distinctly different windward and leeward reefs. The windward reef is typified by a well formed, slightly elevated algal ridge, seaward of which the bottom slopes gradually towards the abyss, while the leeward reef has a less pronounced algal ridge at its outer extremity and slopes sharply, and in some areas vertically, to depths up to 400 m.

The major physiographic features of Enewetak are the reef rim forming the atoll margin, the islands rising above that rim, and the lagoon. A typical vertical profile through an island consists of unconsolidated calcareous sediment above high tide, a thin layer of detrital limestone near sea level, more

unconsolidated sediments and eventually, limestone. The depth to the top of this lower limestone increases somewhat from oceanward to lagoonward. The upper detrital limestone is apparently contiguous with beachrock found around the margin of most of the islands. Sections through the reef are apparently similar to those of the islands, except of course that the supertidal unconsolidated materials and intertidal thin consolidated layer are not found on the reef. There is, however, a "reef plate" of dense limestone on the seaward portion of the reef flat.

Windward Ocean Side Reef Flat at low tide - Enewetak Island

The lagoon probably contains at least 100 meters of sediment overlying consolidated limestone. The sediments are biologically derived calcareous sands and muds. Over 2000 coral pinnacles have been charted in the lagoon.

Enewetak Atoll lies in the North Equatorial Current, and the prevailing water flow is from east to west. Ocean surface waters in the region are very low in inorganic plant nutrients, and oceanic productivity is correspondingly low. The top of the thermocline is near a depth of 100 meters, well below the zone of most active reef growth.

Water enters the lagoon by wave-driven flow over the reef rim and by tidal flow through the three channels. Within the lagoon, the water column is relatively well mixed, and circulation is sluggish. Except for radionuclides, the chemical composition of the lagoon water is not greatly different from that of the surrounding open ocean; radionuclide levels are well above oceanic levels. The composition of the plankton community differs from that of the surrounding ocean, and the standing crop of these organisms is well above oceanic values.

Enewetak has a tropical marine climate with air temperatures ranging from 22 to 34 °C, relative humidity between 73 and 80 percent, and with a mean annual rainfall of about 150 cm. Relatively constant tradewinds averaging about 10-15 m/sec blow throughout the year, with more frequent light air and calms occurring in August through October. Maximum rainfall occurs from July through November (more than 15 cm per month) with most tropical storms and depressions occurring from September through December. Typhoons are uncommon but not unknown. January through March are months of minimum rainfall, averaging less than 5 cm per month. It should be noted that all of these figures are mean values extending over many years. There are considerable year-to-year departures from these means.

Rainfall on the atoll percolates through the porous soil on the islands and contributes to a freshwater lens on some of the islands. The existence of a groundwater system and its dynamics relate to multiple factors such as rainfall, evaporation, size and physiography of the island, geology, tidal fluctuations, and vegetation.

FLORA AND FAUNA

The terrestrial flora of Enewetak has been greatly altered by the activities of man over the past 35 years. The atoll was a Japanese base invaded by U. S. troops during World War II, and the military activity destroyed much of the coconut plantation plantings. Subsequently, the flora was further decimated by the 43 atomic events that took place during the U. S. test program. Only Japtan and the southwestern islands have a nearly undisturbed terrestrial flora. The most conspicuous elements of the terrestrial flora consist of coconut palms, Pisonia, Messerschmidia, Scaevola, and Ipomoea.

The terrestrial fauna includes extensive populations of the polynesian and roof rats, and the coconut crab Birgus latro. The Japanese introduced the large monitor lizard, Varanus indicus, to Japtan Island where it appears to thrive. Several species of geckos and skinks occur throughout the atoll, as do numerous insects. Thirty-two species of birds are reported from Enewetak Atoll, with 9 species known to breed there.

The marine fauna and flora of Enewetak are part of the vast Indo-Pacific biotic realm, and its diversity, coupled with warm, clear and relatively calm waters of Enewetak lagoon have been one of the principal assets of MPML. Corals and their associated organisms are perhaps the most conspicuous feature of

Researcher holds a specimen of Birgus latro, the coconut crab.

the marine community within the atoll ecosystem. The physiography of the atoll is related to biotic zones in which sessile and territorial organisms adapted to the particular conditions reside. Thus rather distinct assemblages of animals and plants are found on windward reefs, lagoon reefs, leeward reefs, lagoon soft bottoms, etc., while other more mobile organisms range widely both within and outside of the lagoon.

Tridacna gigas, the giant clam

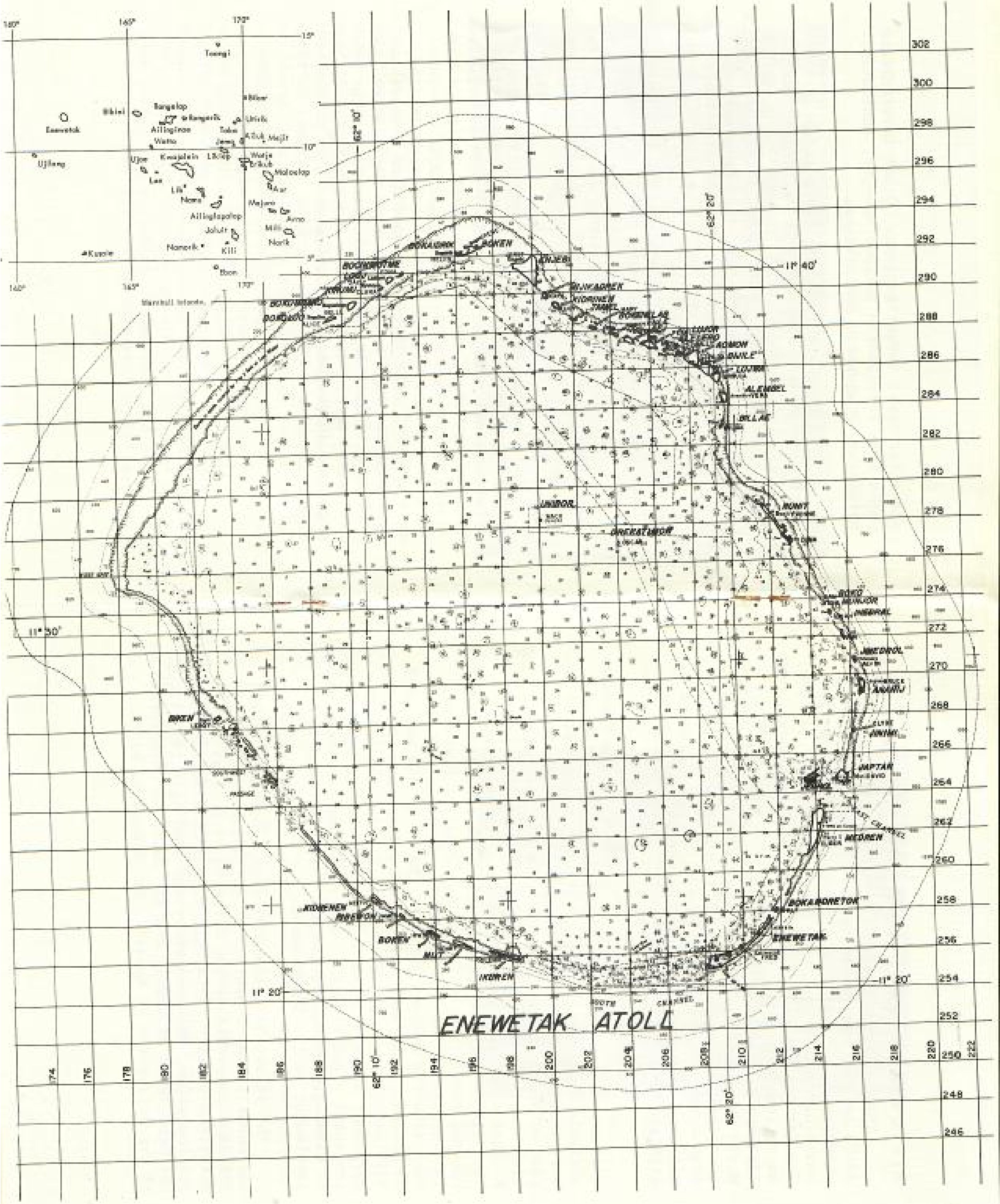
The mollusks in greatest abundance are the gastropods (about 1500 species). Pelecypods are considerably less abundant (about 300 species). Of special interest is the giant clam Tridacna, some reported to weigh over 200 kg and measure over a meter in length. A large number of crustacean species are found in a variety of environments; the crustaceans include crabs, shrimps, lobsters, barnacles, copepods and amphipods. The echinoderms are well represented with some holothurians and echinoids locally found in very high densities. Over 200 species and varieties of corals are reported from the northern Marshall Islands; a majority of these are found within the perimeter of Enewetak and are accessible to study, making the atoll an attractive

place for coral investigations. Other invertebrate phyla well represented include sponges, tunicates, helminths, ctenophora and protozoa.

The shallow water fish fauna of Enewetak is represented by at least 700 species of bony and cartilagenous fishes with diversity to fit a myriad of ecological niches. The hawksbill and green turtle are seen occasionally and have been reported nesting on some of the northern and southwestern islands. At least one species of porpoise frequents the lagoon.

The marine algae of Enewetak have been the subject of several investigations, and over 200 species and varieties have been reported. The composition of the algae is typical of tropical Pacific atolls with the most conspicuous flora being the encrusting calcareous red algae.

Upon establishment of the laboratory, taxonomic specialists were employed to collect and establish a reference collection of the major groups of organisms. This collection is maintained at MPML under the supervision of the Bernice P. Bishop Museum of Honolulu. Since the establishment of the laboratory in 1954, more than 800 scientists have conducted research at Enewetak, and many have contributed material to the reference collection and information to a file maintained on the distribution and ecology of organisms in the Enewetak ecosystem.



ENEWETAK ATOLL
SOUTH CHANNEL
11° 20'
11° 30'
11° 40'
62° 10'
62° 20'
Bikini
Rongelap
Rongerik
Ailinginae
Wotto
Ujae
Kwajalein
Lib
Namu
Ailinglapalap
Jaluit
Namorik
Kili
Ebon
Kusaie
Ujelang
Enewetak
Toongi
Bikar
Utirik
Taka
Ailuk
Mejit
Jemo
Likiep
Wotje
Erikub
Maloelap
Aur
Majuro
Arno
Mili
Nork
Lae
Marshall Islands
BOKOMBAKO
BOKOLUO
KIRUNU
BOKAIDRIK
BOKEN
ENJEBI
MIJIKADREK
KIDRINEN
BOGELAB
AOMON
BIJILE
LUJOR
ALEMBEL
BILLAE
RUNIT
UNIBOR
BOKO
MUNJOR
INEDRAL
JINEDROL
ANANIJ
JINIMI
JAPTAN
MEDREN
BOKANDRETOK
ENEWETAK
IKUREN
MUT
BOKEN
RIBEWON
KIDRENEN
BIKEN

HISTORY OF ENEWETAK ATOLL AND MPML

The Spaniards apparently first sighted Enewetak Atoll in 1526 and landed in 1529. The atoll was surveyed in 1798, and in 1886 the Germans formally established a protectorate over the Marshall Islands. The Germans traded in copra with the Enewetakese, but no resident agent was set up on the atoll. The Japanese seized Enewetak in 1914 as the result of a World War I mandate, and a Japanese trader and two assistants resided on the atoll. During the period 1939 - 1941, the atoll became a strategic Japanese military base with elaborate fortifications and an airfield on Enjebi Island.

The atoll was invaded by U. S. Forces in February, 1944 and it was established as a U. S. base with an airfield on Enewetak Island. At the conclusion of the war, Enewetak with the rest of Micronesia became a part of the Trust Territory of the Pacific Island with the United States as the United Nations Trustee. At that time, 136 Enewetakese were in residence on the island. In 1947, the people were transferred to Ujelang Atoll, 200 km to the southwest of Enewetak, in preparation for the use of the atoll as a U. S. test site for nuclear devices. Between 1948 and 1958, 43 nuclear tests were conducted on Enewetak. Between 1958 and 1974, it was used for other quasi-military purposes; in 1972-3 the U. S. Atomic Energy Commission conducted a radiological survey of Enewetak preparatory to cleanup, rehabilitation and the return and re-settlement of the Enewetakese.

The Eniwetok Marine Biologcal Laboratory (EMBL) was established on Medren Island, Enewetak Atoll, in 1954 and supported by the Division of Biology and Medicine of the U. S. Atomic Energy Commission. Since its inception, the laboratory has been operated through the University of Hawaii and the Research Corporation of the University of Hawaii. Dr. Robert W. Hiatt

Dr. Robert W. Hiatt, first director of Eniwetok Marine Biological Laboratory

served as EMBL Director until 1969, when the position was assumed by Prof. Vernon E. Brock. In 1970, Dr. Philip Helfrich was appointed Director, and on 1 July 1974, the old EMBL was reorganized, upgraded to a year-round operation and renamed the Mid-Pacific Marine Laboratory (MPML). On 1 January 1975, Dr. Stephen V. Smith assumed directorship of MPML.

Dr. Stephen V. Smith present director of the Mid-Pacific Marine Laboratory

Besides the laboratory managers and temporary MPML personnel, other atoll inhabitants include operations and maintenance contractor personnel numbering about 20 persons, about 10 persons at a Coast Guard Loran station, and other individuals on temporary duty there. The Defense Nuclear Agency is presently the host organization for all activities on the atoll.

It is hoped that materials left on the atoll by U. S. activities there will be cleaned up, that the islands will be rehabitated, and that the Enewetak people (now numbering about 400, most of whom live on Ujelang Atoll) will then be able to resettle their home.

FACILITIES AND SUPPORT

The Mid-Pacific Marine Laboratory is located on Enewetak Island in the southeastern quadrant of the atoll. The laboratory is presently housed in a corrugated aluminum building and has approximately 650 m^2 of floor space, including a large general laboratory area, a covered wet laboratory with

Interior of main laboratory

seawater tables, a shop area, and air-conditioned offices, instrumentation room, chemical and glassware storeroom, darkroom, library, lounge, radio communication center, and manager's office. Tentative plans call for the construction of a new building.

Various common analytical chemicals, supplies, and instruments are maintained at the laboratory, and the inventory of these materials is constantly being increased. The library includes a modest selection of useful scientific references, with special emphasis on texts and reprints pertaining to the tropical Pacific Ocean. The laboratory also houses an extensive reference collection of the biota (primarily the marine biota) of Enewetak Atoll.

MPML Library

For field use, the laboratory maintains several small boats to provide transportation about the atoll. SCUBA tanks, backpacks and weights are available for use by qualified divers. Prospective divers are advised to furnish any other gear they require. Camping gear is available for overnight stays off the "home" island of Enewetak. A trailer equipped with sleeping,

Preparing to dive from one of the MPML small boats

cooking, and working facilities is located on Enjebi, one of the northern islands of the atoll.

ERDA maintains a 35-meter LCU for scientific use in the Marshall Islands. The vessel operates out of Kwajalein Atoll, 700 km southeast of Enewetak. It is expected that this vessel will be especially valuable in enabling researchers to transport

temporary laboratory capability to other atolls in the Marshalls for comparative studies. With adequate prior notice, it is possible to arrange for the use of the LCU at Enewetak or elsewhere in the Marshall Islands in conjunction with MPML activities.

Liktañur, 35 meter LCU research vessel

The laboratory maintains at least one motor vehicle for use by visiting scientists. Bicycles are also available for travel about the island. All of the islands are sufficiently small to be covered on foot.

The laboratory has a resident manager and an assistant manager. These individuals both have scientific operations experience and are qualified SCUBA divers so that they can provide ample support for visiting scientists. Up to 12 scientists may

ordinarily be accommodated at the laboratory. Under exceptional circumstances, arrangements may be made to accommodate additional persons.

Dormitory rooms, including towels and linens, are provided for MPML scientists. Meals are served in the dormitory mess hall. A camp store is open several hours a week and carries a limited stock of miscellaneous personal items. There is a U. S. Post Office, and mail is sent and received on the weekly airplane flights.

Recreational facilities at Enewetak include nightly movies, tennis courts, salt-water swimming pool, pool tables, shuffleboard table and a bar. Recreational diving and fishing are obvious, popular sports.

RESEARCH SUGGESTIONS

Enewetak Atoll has been the site of extensive scientific research over the past three decades. These previous efforts have increased our knowledge of the atoll to the point where some rather specific suggestions for further study can be offered.

1. Research synthesizing previous studies, and leading towards a better understanding of Enewetak Atoll is of primary interest to MPML.

2. Efforts to elucidate the roles of the major components in the atoll system, including man, are encouraged. Of particular interest in this respect are the distribution of these components and the flux of materials between components, that is, the cycling of materials through the ecosystem.

3. Enewetak has been subjected to numerous "spikes" in the form of radioactive residue from the nuclear test devices detonated there. Research utilizing the radioactive products of those spikes is appropriate.

4. Research leading to an understanding of the dynamics of radionuclide deposition and migration in, and removal from, the coral atoll environment is especially encouraged.

5. Research related to conservation and utilization of atoll resources by inhabitants of the atoll is encouraged.

6. Finally, research and studies relating our understanding of the Enewetak ecosystem to other atolls, including especially Bikini, will be given favorable consideration.

The following ongoing or recently completed studies serve as examples of programs of particular interest to MPML:

1. Nutrient flux and community metabolism on the windward reef flat;

2. Density and radiographic band patterns in corals and their relation to environment;

3. Physical transport and nutrient chemistry of lagoon waters;

4. Dynamics of the plankton community in the lagoon;

5. Hydrogeochemistry of the islands.

SELECTED REFERENCES

Dawson, E. Y. 1957. An annotated list of marine algae from Eniwetok Atoll. Pacific Science 11:92-132.

Emery, K. O., J. I. Tracey, Jr., and H. S. Ladd. 1954. Geology of Bikini and nearby atolls. U. S. Geological Survey Professional Paper 260A:1-265.

Hiatt, R. W. and D. W. Strasburg. 1960. Ecological relationships of the fish fauna on coral reefs of the Marshall Islands. Ecol. Monogr. 30:65-127.

Hines, O. 1962. Proving ground; an account of the radiobiological studies in the Pacific, 1946-1961. Seattle, Univ. of Washington Press 366 pp.

Johannes, R. E., et al. 1972. The metabolism of some coral reef communities: a team study of nutrient and energy flux at Eniwetok. BioScience 22:541-543.

Odum, H. T. and E. P. Odum. 1955. Trophic structure and productivity of a windward coral reef community on Eniwetok Atoll. Ecological Monographs 25:291-320.

Schultz, L. P., W. M. Chapman, E. A. Lachner and L. P. Woods. 1953. Fishes of the Marshall and Marianas Islands. U. S. National Museum Bull. 202. 3 vol.

Wells, J. W. 1954. Recent corals of the Marshall Islands. U. S. Geological Survey Professional Paper 260I:385-486.

STAFF

Director: Stephen V. Smith

Laboratory Managers: Phillip and Janet Lamberson

Logistics: Paul Allen and Francine McShane

Communications: Maridell Foster

Librarian: Martha Hoverson

Secretary: Mae DeRego

Cover photo: covered wet lab area, Mid-Pacific Marine Laboratory

November 1975

APPLICATIONS

Proposals for research at MPML are invited from individual researchers. The proposals will be evaluated on the basis of scientific merit, suitability to local conditions, and relevance to the research emphasis established by the MPML Scientific Advisory Committee.

Support for visiting scientists may include air fare to and from Enewetak, subsistence at Enewetak, and access to supplies and logistic support at the laboratory. Researchers with proposals which are considered to be meritorious but outside the laboratory mission may be invited to use the laboratory at their own expense and on a space-available basis. Cooperative research programs with support from outside MPML are encouraged.

Proposals for research to be conducted between 1 January and 30 June should be submitted by 1 October of the preceding year. Proposals for the period 1 July through 31 December should be submitted by 1 April. All inquiries should be addressed to the Director, Mid-Pacific Marine Laboratory, P. O. Box 1346, Kaneohe, Hawaii, 96744.

George 4/76

Your letter to Epicurya succeeded. He has published a conservation instruction which does not allow any turtles to be taken. It does allow live shell & fish collecting but no commercial collecting. It also protects coconut crabs on Ikuen, Mut, & Biken. (Glenn, Henry, & Leroy).

The straw which may have broken the colonel's back was a mounted & preserved coco. crab which some of the H&N guys tried to give the Col. as a gift. - It backfired.

Chang said the hawksbill shell "had been chipped." He did show me a green shell about 36" from rear

the wrecked ship by the motor pool. I will maybe get around to X ray film it. The skipper's shell seemed to show some activity with the "Fiddler" detector but is very near background & I must set up a second detector as a background simultaneous standard.

No picture from Lewiston.

I will be going on vacation 15 Dec and probably will be too busy beforehand to dig for turtle eggs. Paul Allen will be here >8 Dec

— duplicate slides
— carry out all tests possible on available material
— need long bones probably
— Should it be dug up till late December every natural thing will happen has happened

Phil & Jan

TURTLE SIGHTING REPORT #1

Please return to: George H. Balazs
HIMB-P.O.Box 1346
Kaneohe, 96744
Tel. 247-6631 or
946-1760

ion made by: Robert Myers

Oct 29 Time: 4:30 PM

(indicate on chart) Spur+groove zone near wreck of Sati Maru off Yvonne

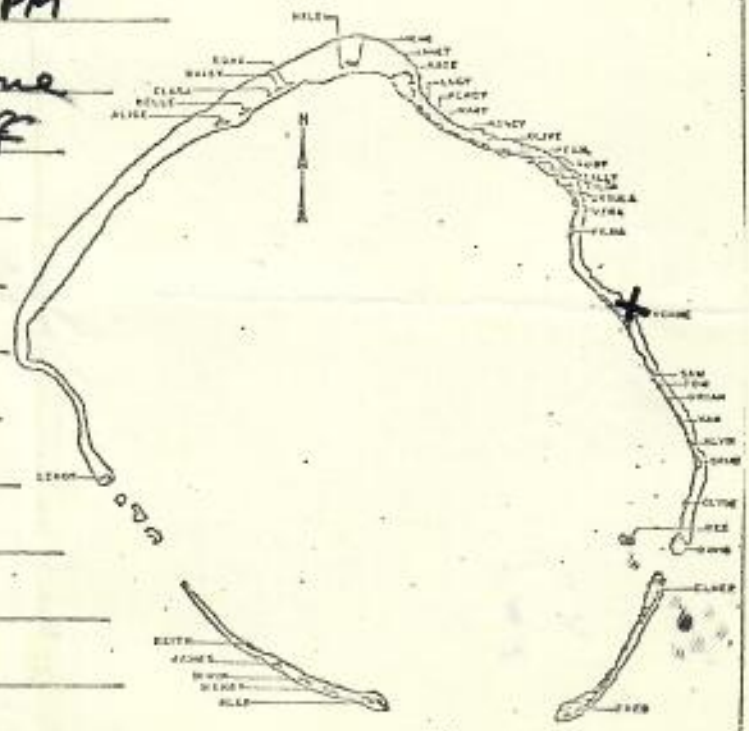
ate size (shell length): .8- 1.0 m

ishing characteristics: Couldn't see any - too far away

ion made: at surface

neath surface (depth) 3 m

neous comments:



TURTLE SIGHTING REPORT #2

Please return to: George H. Balazs
HIMB-P.O.Box 1346
Kaneohe, 96744
Tel. 247-6631 or
946-1760

ion made by: Robert Myers

Oct 30 Time: 5:40 PM

(indicate on chart) Spur+groove zone off wreck of Sati Maru off Yvonne.

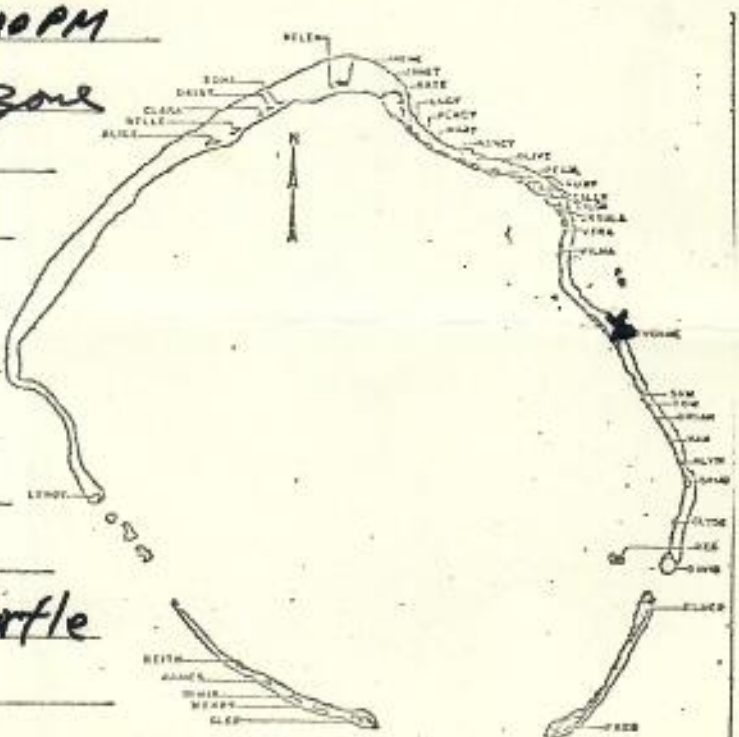
ate size (shell length): .8 - 1.0 m

ishing characteristics: Couldn't see any - too far away

tion made: at surface

eneath surface (depth) 3 m

aneous comments: Probably same turtle as the day before



attach with

May 1982

Memo to: George Balazs HIMB

From: R. Schroeder, Oceanography

Concerning: liquid scentillation on turtle bone from Eniwetak.

Methods & Results

Using a dremel tool, a sample was collected from the turtle bone. Attempts to dissolve the powdered sample in HCl and HNO_3 were unsuccessful; & also Protosol (New England Nuclear) tissue solubilizer was not successful. The sample was treated with 30% H_2O_2 to oxidize the organic material. This did not improve dissolution.

The sample (25mg) was leached in Protosol acidified with HCl & nitric acid - filtered & diluted up to 10ml with

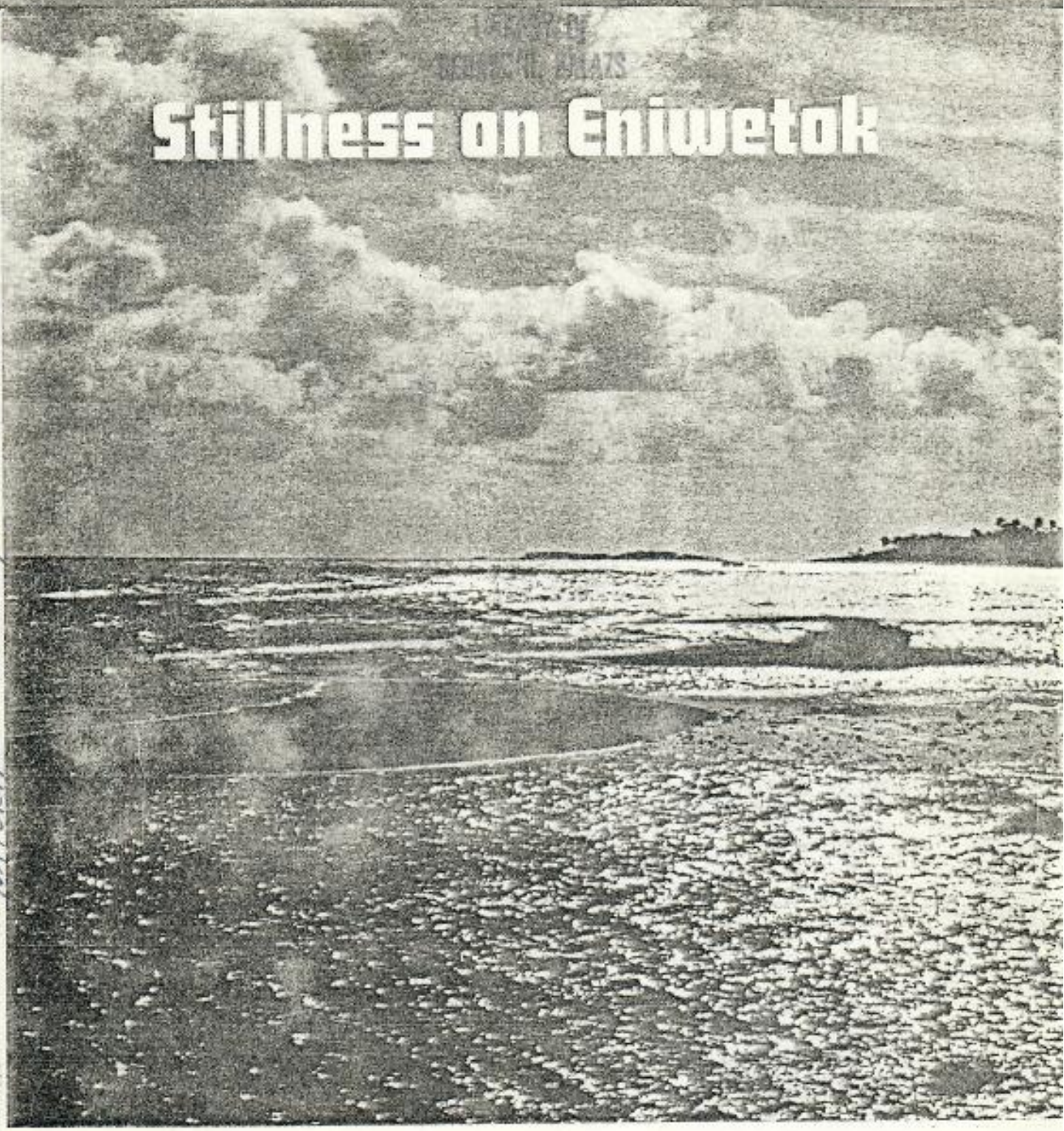
Aquasol (LSC cocktail.)

The sample was counted in a Beckman CPM-100 Scintillation counter (ultra very low background) at 3 energy channels corresponding to ^{32}P, ^{14}C and ^{3}H. The gain was adjusted to minimize quenching.

No activity above Background was detected (20 min counts - 10 cycles)

This technique is sensitive to α or β^- radiation. Because of the difficulty in dissolving the sample, I can't really say there was no α or β^- activity.

Gama?



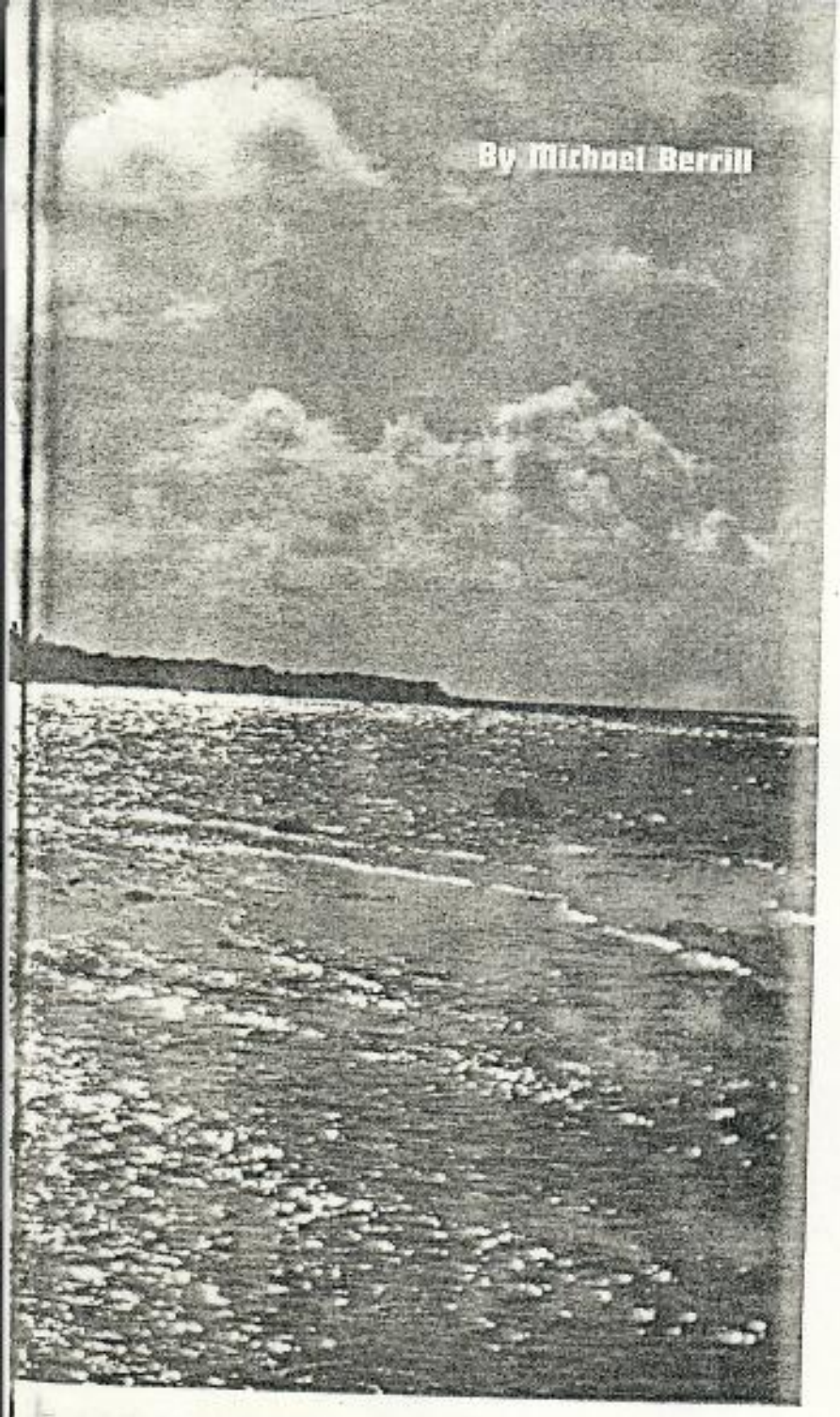
Stillness on Eniwetok

A young biologist's impressions of island life

Eniwetok Atoll is a horseshoe of sand islands and reefs, 10 hot degrees north of the Equator among the Marshall Islands of Micronesia. Here the sun is dazzlingly bright; the sunsets brief, but beautiful. Here an observer can catch a glimpse of the traditional tropical paradise of sparkling seas and swaying coconut palms. But only a glimpse, for Eniwetok has witnessed some of the most savage events of this century.

The atoll, like others in the Pacific, is a coral reef, alive and growing, responding almost as a unit to the daily measure of light from the sun. It rests on a cone of dead coral a thousand feet thick, which in turn covers the top of a submerged mountain several miles high. The reef encloses a lagoon that, although it is as much as twenty-five miles wide, is no more than a couple of hundred feet deep. Where the reef projects above the surface of the water, sma islands of sand have formed; whe the sand is deep enough, some bush and trees have grown, depositing soil of sorts above the sand and pr viding a habitat suitable for human

The first people to settle on th atoll came from the great melting p of Southeast Asia. Negrito, Vedd Caucasoid, and Mongol mixed Malaya and Indonesia, and under t steady Mongol pressure from t



at a former nuclear test site

north, began to emigrate across the Pacific more than fifteen hundred years ago. They came in successive waves, some as much as centuries apart. One of the later waves remained in Micronesia instead of moving on to the larger, more hospitable islands of Polynesia.

The Marshall Islands were unrecorded in the West until Captain Marshall, returning to England with a cargo of Cantonese tea in place of the British convicts he had deposited at Botany Bay, sighted them in 1787. But for a hundred years afterward the islands represented little more than dots on European maps, telling of reefs that sailors should avoid. The inhabitants, the Marshallese, led placid lives in the meantime. They grew coconut palms in plantations where the soil was thick enough, and they fished from the abundant reefs in the lagoons. Like other Micronesians, they traveled in all directions to neighboring atolls. They remained, despite such a predilection for travel, free of other societies until the 1870's, when they were absorbed into the expanding German Empire and their copra trade came under German management. In 1920, a League of Nations mandate gave control of the Marshall Islands to Japan. It, in turn, supervised the copra trade until the islands were closed off from the rest of the world in preparation for World War II.

The Marshallese of Eniwetok were forced to accept first the Germans and then the Japanese. During the Second World War they moved to the northern islands of the atoll, away from their homes on the larger southern ones, fleeing a war that concerned a world of which they had little conception. In February, 1944, 200 Americans were killed in the successful capture of Eniwetok Atoll—a battle in which, according to their orders, 2,600 Japanese died in a struggle they could not have hoped to win. All for an atoll that has only two and a half square miles of sandy land exposed when the tide is high.

With the war's end, the Marshall Islands came under United Nations trusteeship with the United States appointed to guide them in their own interests. The civilian-controlled U.S. Atomic Energy Commission, created in 1946 to supersede the U.S. Army Corps of Engineers' Manhattan District (the agency that guided the development of the atomic bomb), sought a testing site that was sufficiently isolated from large concentrations of human population and that had a warm and relatively stable climate. The site also had to be located where detonation would not severely harm commercial fisheries. The Marshalls, minute atolls in the largest of oceans, looked ideal and were finally selected. The Marshallese living too close to the test area were moved to other atolls before testing began, which occurred first at Bikini and then at Eniwetok Atoll. In 1952 the first thermonuclear bomb was exploded on a small island at the northern end of Eniwetok. Henceforth—except for highly controlled situations—radiation from nuclear bomb tests would no longer be limited to local ecosystems, but instead would enter the atmosphere of

Often on Igurin a White Fairy Tern hovers silently several feet above the head of a visitor and simply stares at him, sometimes for minutes.

the earth and be dispersed globally.

Several detonations followed in 1954, including the well-publicized explosion at Bikini that came to involve the crew of a Japanese fishing boat. But since the 1958 Geneva Test Ban Agreements, the atolls have been silent. In fact, by 1961 the Atomic Energy Commission had lost interest in the atolls and had transferred control of them to the U.S. Department of Defense for development in the Pacific missile range. Curiously, the atolls have returned to the jurisdiction of a military agency.

Despite the events of the last forty years, there are several islands of Eniwetok Atoll that have remained largely undisturbed by war, nuclear tests, and military installations. One of these is Igurin Island, and only the regular rows of coconut palms in the overgrown plantations tell of a time when the island was known and cultivated by the Marshallese. Today it has no inhabitants. Instead, it has palm trees, sunshine, sand, and sea, and most of the animals that are associated with a tropical coral island. Here, indeed, is that glimpse of paradise where one must discard his own civilization so that he may feel a part of what he sees.

The coconut palms dwarf the rest of Igurin's vegetation, their fronds swaying and rattling in the winds. Once these trees fed, clothed, and housed the natives, but now the coconuts fall to the ground to rot or to be eaten by island scavengers. A low silver-barked tree, *Pisonia*, typical of atoll growth wherever there is sufficient soil, and the scrub bushes *Scaevola* and *Messerschmidia* cover most of the island. The bushes and trees are the nesting sites for two tropical species of terns, and Igurin is a home for thousands of each.

The two kinds of terns nest and roost peacefully together and fish together offshore. They may join forces to mob a heron or a frigatebird that approaches too near the nesting sites, and both try to discourage a human intruder by diving at him, veering off almost reluctantly only at the last second. One is the Noddy Tern, a dusky, chunky bird. The other could hardly look more different. It is a smaller bird of fine proportions, totally white except for black eyes and bill, and named, most appropriately, the White Fairy Tern. Each lays only a single egg in its nest, but the Noddy often builds its nest on the ground, whereas the Fairy nests exclusively in the trees. The White Fairy Tern is the more

A Sally Lightfoot scampers off to the protection of the water. At right, ghost crab excavations line a portion of beach above high-tide level.

curious, often hovering a few feet over an intruder and cocking a black eye at him. It is also the more playful, for pairs often fly, soar, chase, and tumble together over the island. Yet in all this—fishing, dive-bombing, mobbing, curiosity, and play—the White Fairy and Noddy Terns are strangely silent. A hundred birds may jump into flight, but only the beating of their wings is heard against the perpetual background of wave and wind.

The nesting sites of sea birds throughout the world's tropical oceans are among the favorite hunting grounds of the impressive frigate-bird. Igurin is no exception, for every day five or six frigate-birds soar effortlessly above the island for hours on end, scarcely moving a wing as they rise and fall with the air currents. With an eight-foot wingspread and a deeply forked tail used for steering and braking, the frigates are known as the most acrobatic of birds, reputed to steal food from other flying sea birds, to catch flying fish in mid-air, and to sweep in on nesting sites of boobies, terns, or even other frigate-birds and snatch up unwary chicks. Of all the birds that fly beautifully, the frigates appear to take the most pleasure in their own movements. They are unparalleled in the air; there they rule.

Other birds visit Igurin. Boobies occasionally fish off the edges of the reef; the solitary Reef Herons stalk the shallow reef waters; the Noddy Turnstone and Bristle-thighed Curlew search the water's edge.

There is little other daytime activity on the island. Living in the leaf litter is one of the more elusive of the inhabitants, the small blue-tailed skink, a darkly polished lizard with long golden stripes along its back. It hunts for insects in the litter, acting with extraordinary agility when the slightest disturbance. It is not often caught unawares, for it has a small transparent window in the center of its lower eyelid through which it can detect movement when the eyelids are shut, an adaptation that many skinks have for eye protection and vision while burrowing.

At night all is usually still on Igurin. The terns roost silently in the trees. Occasionally a White Fairy tern is aroused from its perch and, in the darkness, slowly picks its way through the branches, its wings frantically beating. More often, the birds remain undisturbed. Only the nocturnal scavengers are active, exploring the undergrowth for anything that can be eaten.

One of these scavengers is the small, brown Polynesian rat, which now lives on islands throughout the Pacific. It spread from island to island on floating rafts and in native canoes, and it has prospered on the fruit of the palm trees, climbing for the young fruit or eating those fallen and broken on the ground. The Eniwetok population of this little rat has become justly famous since the testing of the hydrogen bomb. The bomb was detonated over one of the small, almost barren sand islands at the north end of the atoll. It produced, until the sediment began to resettle, a crater two hundred feet deep where the island had been only moments before, and it sent a great wave of water to swamp adjacent islands. The size and effects of the blast were far vaster than anyone had anticipated. The blast and its wave of water killed the vegetation of the nearer islands, left their sea birds sick and dying, and covered the sea with dead reef fish. Strangely enough, when damage on the islands was being carefully surveyed, a few rats were discovered still alive and unhurt where all else had been destroyed. The time since the blast was too short and the distance from the unaffected islands too long for new rats to have repopulated these islands. How they survived no one knows for certain. Perhaps they were protected by their burrows or by the foundations of some of the military installations, but some had lived.

The rats on Igurin share the fallen coconuts with that most magnificent of crabs, the coconut crab. Steel blue, with long legs and viselike pincers, sometimes six inches across the carapace and as much as a foot and a half long, the coconut crab was once a source of meat for the Marshallese. The testing of the bomb, however, changed this. New scrub vegetation and new populations of sea birds and fish have replaced some of what was killed, and the radioactive contamination of the water and its organisms has become sufficiently diluted to be quite safe. But the coconut crab has continued to concentrate small amounts of the radioactive isotope of

Its legs securely hugging the trunk, a coconut crab shins up a coconut tree. In the Marshalls, the crab is radioactive and unsafe to eat.

A land hermit crab, Coenobita, is about to feed on a fallen coconut. The opening in the fruit has been neatly incised by claws of coconut crab.

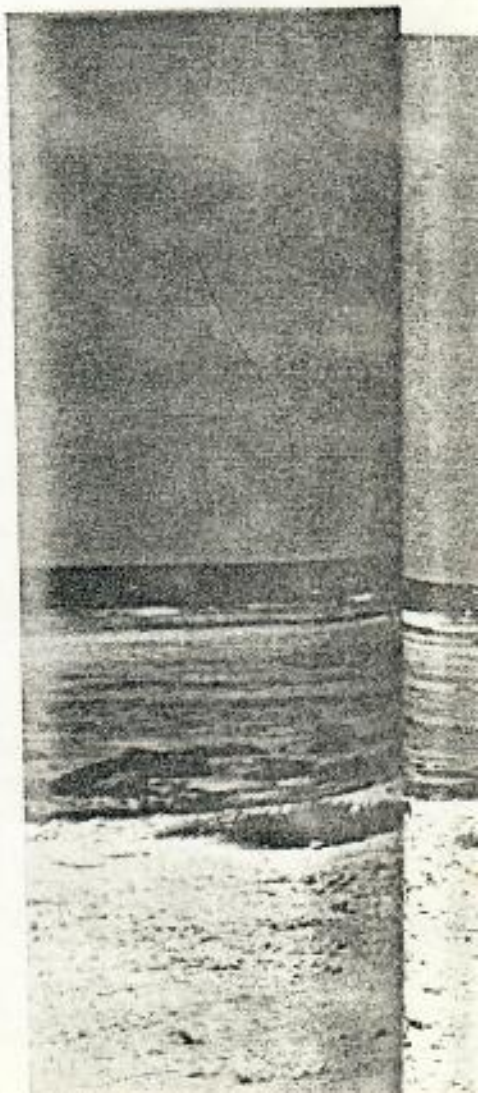
The spotted egg of a Noddy Tern lies among shells, pebbles, and driftwood in a loosely built ground nest. The Noddy is a dark, chunky bird, which, like the White Fairy Tern, fishes both in lagoons and the open ocean.

the trace element strontium, and so is unfit to be eaten.

Safe from human predation, at least on Eniwetok, the coconut crab, nevertheless, remains a shy creature. It is able to live only on islands where there is vegetation and where men seldom come, and Igurin is such an island. Here hundreds of coconut crabs roam the undergrowth every night. When one is attacked or annoyed, it backs off in rapid spurts, clapping its abdomen sharply under the rest of its body. Normally, it plods slowly forward, only occasionally climbing *Pisonia* or coconut trees. No one has ever seen a coconut crab actually cut a coconut from a treetop: perhaps it climbs the trees to eat young leaves. However, the shredded husks and neatly broken shells of the fallen coconuts are evidence of the dexterity of the crab, which pulls off the fibers of the husk in thin strips and then breaks open the hard shell by inserting the fine finger of its claw into one of the soft eyes of the nut and starting to cut from there. What the coconut crab doesn't eat of the coconut meat, rats, hermit crabs, and insects undoubtedly do, although the rats are quite capable of gnawing their way to the meat by themselves.

When they are not searching for sex at night, the crabs live in burrows under tree roots or rocks—wide burrows sometimes several feet deep. Although they are land crabs, they begin life as marine larvae that settle on the ocean bottom and live for awhile like typical hermit crabs, occupying the empty shells of small marine snails. Later they leave the sea and crawl up the beach into the woods, retaining their shells until the crabs grow too large and too tough to need them any longer. During the summer the adult female bears a great cluster of orange and purple eggs under her abdomen, and when they are ripe she leaves the woods, crosses back down the beach, and dips her abdomen into the water. Instantly, the ripe eggs hatch and the larvae swim away, while the eggs that are not yet ripe remain attached and intact.

The coconut crab is not alone on Igurin as an emigrant from the sea. The land hermit crab, *Coenobita*, pokes about in the undergrowth scavenging for food, but can only eat coconuts that have already broken open. When the season is right—the time of the new moon in midsummer—hundreds of these bright-red animals gather on the beach late in the evening for a night



oddy Tern lies
and driftwood
nd nest.
chunky bird.
Fairy Tern, fish
e open ocean.

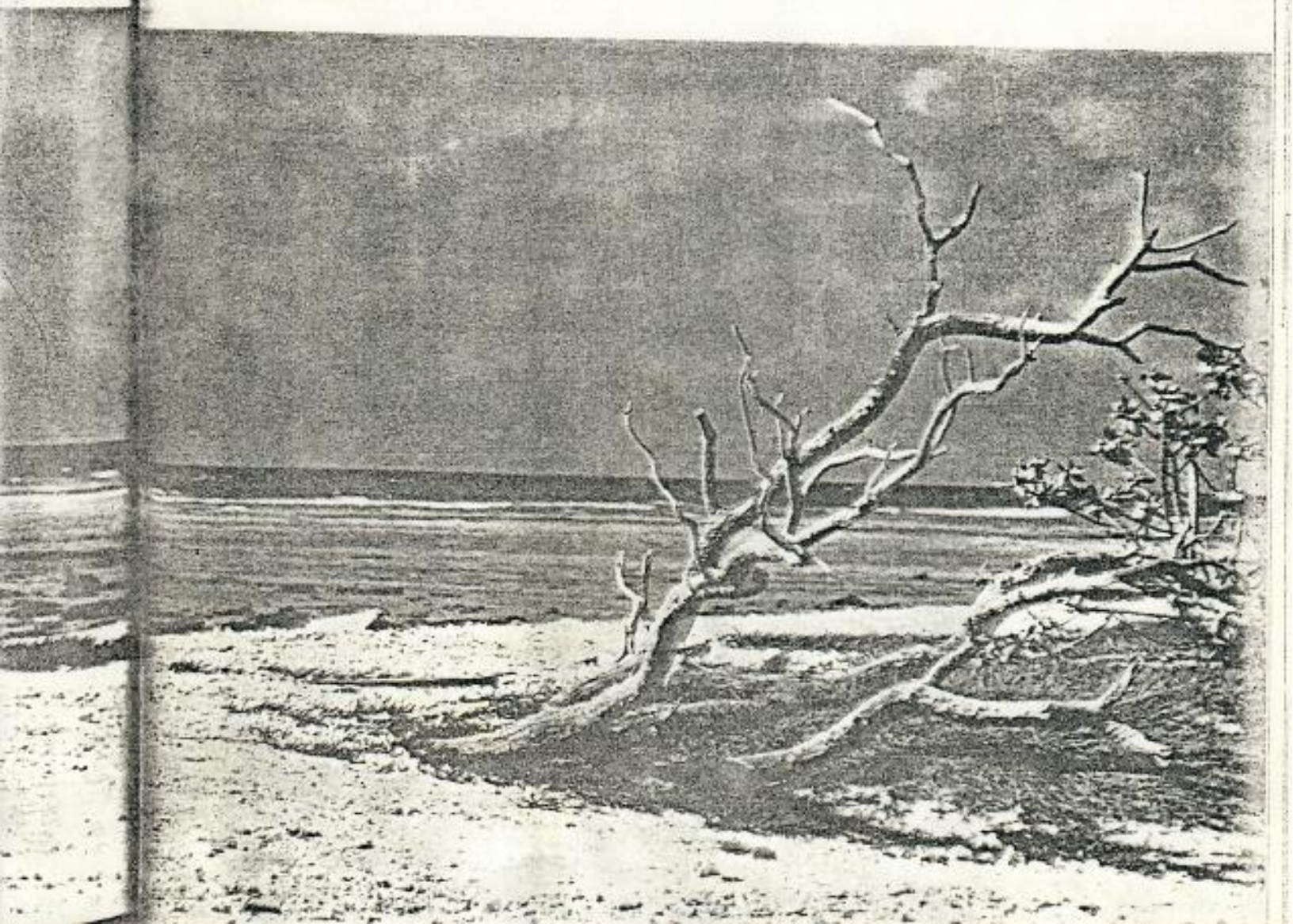
ner of bumping shells. The occurrence of such an evening seems to bear some relationship to moon phase and day length, a relationship that bespeaks a strong internal physiological clock and results in the reproductive synchrony so important for the success of the species.

A proper sideways walking crab often wanders along the shore at night, but the moment it is disturbed it careens madly away across the rocks to the security of the water, barely touching the ground, and because of its swiftness earning its common name, Sally Lightfoot. And ghost crabs—fast, silent, and pale—dance along the water's edge during the night, returning at dawn to their burrows in the sand above the high-tide level. Neither crab competes with the land hermit crab or the coconut crab for the food of the underbrush. Their smaller claws and their fleetness of foot render them more adapted to searching for organisms along the beach and rock ledges, and neither can tolerate prolonged exposure to the drying winds.

All four of these crabs are shy, yet each is unique. Each has its own particular habitat, its own means of defense and feeding, its way of homemaking, its own specific sexual behavior. To varying extents these crabs represent an escape from the sea onto land: the coconut crab leaving it most completely, Sally Lightfoot never far from its safety. They are the link between the world of heat and light, sand and palm trees, and the very different world of the sea and its reefs.

The coral reef community is one of the richest and most complex on earth, for here a vast array of animals make use of an abundance of niches. The reefs of Eniwetok are no exception. Corals grow in strange shapes and sizes; plumed tube worms withdraw abruptly at the slightest passing shadow; giant clams wedge securely in the coral heads, exposing only their brilliant mantles; reef fish with extraordinary colors flit among the corals; and large, solitary fish, including sharks, quietly search the reef for food.

Beneath the surface of the tropical sea all is cool and nearly silent. Above it is the heat, the brightness, and the dryness of another world. Each evening brings a sunset more beautiful than the last; each day brings, amidst the heat and brightness, a rainstorm to rival the torrential downfall of the day before. Rarely is there a day without a trade wind to make the heat bearable, and every night when the moon is not up, it seems as black as night could ever be. Here, once again, the universe and its nature is the way it has been for eons, essentially untouched and unchanged by humanity. Here a man's footprint, however deep, soon washes away.



DEFENSE NUCLEAR AGENCY
ENEWETAK ATOLL, FIELD COMMAND
APO SAN FRANCISCO 96333

FCR 6003
November 1976

OPERATIONS

ENEWETAK ATOLL CONSERVATION POLICY

1. PURPOSE: To outline policies pertaining to marine and terrestrial wildlife conservation at Enwetak Atoll, Marshall Islands.

2. REFERENCES:
   a. U.S. Endangered Species Act, 1973 (16 USC 1531-1543)
   b. U.S. Marine Mammal Protection Act (16 USC 1361)
   c. Trust Territory of the Pacific Islands Endangered Species Act, 1975 (Public Law 6-55)

3. APPLICABILITY: The policies contained herein are applicable to all personnel at Enwetak Atoll, Marshall Islands. Whoever willfully violates these policies is subject to removal from or denial of future access to Enwetak Atoll as well as possible prosecution under appropriate laws.

4. RESONSIBILITIES:
   a. The Commander, Enewetak Atoll (COMEA) is responsible for establishing, implementing and enforcing this policy by:
      (1) Insuring that all permanently assigned and transient personnel are fully cognizant of endangered species protected by United States law and Trust Territory law at Enewetak Atoll.
      (2) Insuring that all personnel are aware of restricted areas within the atoll, which have been identified by the Manager, Mid-Pacific Marine Laboratory (MPML) for scientific study of marine species.
      (3) Insuring that copies of this policy, including a map showing restricted areas, are posted in prominent locations.

   b. The Base Support Contractor Resident Manager is responsible for implementing and enforcing these policies during the absence fo the COMEA.
   c. The Manager, MPML, is responsible for:
      (1) Advising the COMEA on matters concerning on-going scientific studies which impact upon policies contained herein.
      (2) Insuring that scientists/users of MPML facilities conform to these policies.

(3) Reporting observed or suspected violations to the COMEA for appropriate action.

5. POLICIES: The following conservation policies are in effect for Enewetak Atoll:

a. Hawksbill Turtles will not be harrassed or captured, nor will any Hawksbill Turtle eggs be collected.

b. Green Turtles will not be harrassed or captured, nor will any Green Trutle eggs be collected.

c. Marine Mammals (e.g. whales. porpoises) will not be disturbed or molested.

d. Coconut crabs will not be collected on Ikurin (Glenn), Mut (Henry) or Biken (Leroy) unless specifically authorized by the COMEA.

e. Monitor lizards will not be collected on Japtan island.

f. No wildlife or domesticated animals will be introduced into the environment of Enewetak without permission from the COMEA.

g. Collection of tropical fish, shellfish or any other marine organism for commercial export is prohibited.

h. To the maximum extent possible all plant and animal life will be undisturbed. Visitors to any island will excercise care when entering bird nesting areas to avoid unnecessary contact with or damage to nests and occupied nesting habitats.

i. The following areas within Enewetak Atoll have on-going scientific studies being conducted and are therefore declared restricted areas (See Enclosure 1).

(1) Enewetak Island Quarry (Note 1 on Encl.)
(2) North Enewetak Pinnacle (Note 2 on Encl.)
(3) South Medren Pinnacle (Note 3 on Encl.)
(4) The flat shallow reef area to the North of Japtan from the shoreline to 200 meters North (Note 4 on Encl.)
(5) The USERDA/LLL Garden Project on Enjebi Island (Note 5 on Encl.)

Personnel, other than authorized ERDA sponsored scientists utilizing MPML facilities conducting studies in the above areas, will refrain from collecting sea life in these areas.

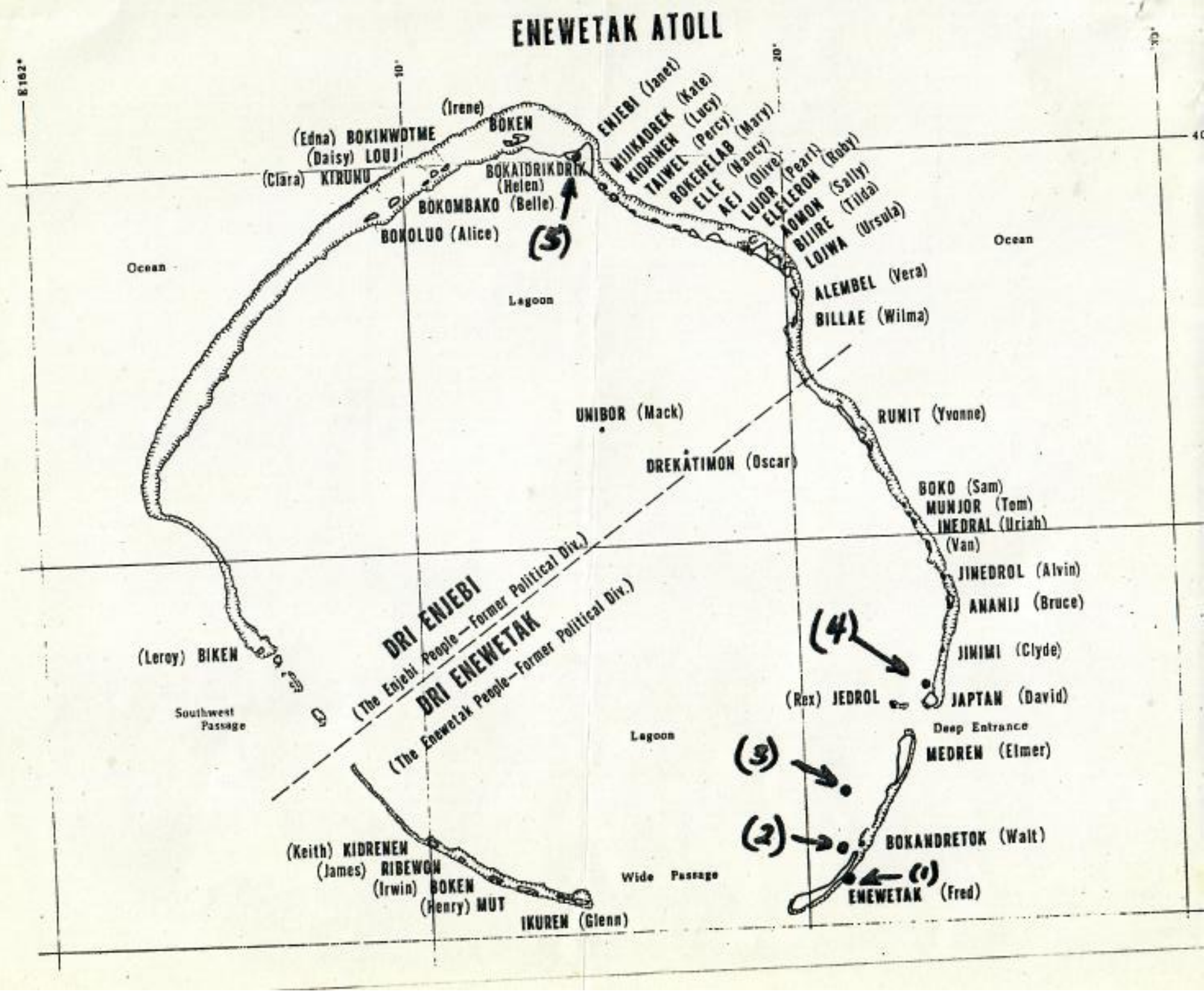
j. Recreational fishing is permitted at Enewetak. Fish and crustaceans (e.g. lobster) will be for local consumption only and will not be exported from the atoll for commercial purposes.

William L. Spicuzza

WILLIAM L. SPICUZZA
LTC, USA
Commander

Encl: Map of Restricted Areas

ENCL TO FCR 6003 - Restricted Areas



BISHOP MUSEUM
1525 BERNICE STREET • P.O. BOX 19000-A • HONOLULU, HAWAII 96819 • (808) 847-3511

7 January 1983

Mr. William Gilmartin
Marine Mammal & Endangered Species Program
National Marine Fisheries Laboratory
P.O Box 3830
Honolulu, Hawaii 96812

Dear Mr. Gilmartin,

Through the auspices of the Mid Pacific Research Laboratory, Enewetak Atoll, Marshall Islands, a book on the Natural History of Enewetak Atoll is being prepared for publication by the Department of Energy. We have sought specialists in various disciplines to contribute to this book. As editor of the systematics section, I have a group of about 26 scientists preparing chapters. I have tentatively approached Dr. George Balazs from your staff to inquire whether he has the information and wishes to contribute on marine turtles. Apparently he has enough data to present a short chapter for the book. I have indicated a deadline for the end of March 1983, which George feels is possible to meet.

Naturally as his supervisor, I wanted to let you know that we would look forward to George's participation in this comprehensive volume. Acknowledgement of your program through his affiliation would be made.

Sincerely,

Dennis M. Devaney

Dennis M. Devaney
Div. Invert. Zool.

cc: Dr. George Balazs

DMD:jp

AUTHOR

Send the best available copy of the manuscript, the original line drawings, and continuous-tone glossy prints of the photographs.

COMPLETE AND SIGN THE COMBINED RELEASE AND COPYRIGHT STATEMENTS.
(A guide for requesting permission to reprint is included for your assistance.)

If you change your address before you receive the galleys of your chapter or your copy of the published proceedings, please notify the

Special Publications and Editing Division
Technical Information Center
U. S. Department of Energy
P. O. Box 62
Oak Ridge, Tennessee 37830

Make the title of your chapters short and descriptive. Avoid using Latin names (e.g., genus and species) in titles.

Include an abstract. As a condensation of the significant information in your chapter, the abstract should be the most precisely and concisely written part of your paper.

Cite in the body of your chapter each entry listed in the reference section and describe each reference fully.

If you include an acknowledgment section, place it preceding the reference section. Acknowledge contract, special support, etc., as appropriate.

Give each table a title and each figure a caption. Make them brief and explicit.

Use illustrations only when they are needed to explain the text. Generally, cite significant points in the captions and give details in the text.

Do not use company names or trade names unless the validity or the reproducibility of the work you are describing depends on them. (Government Printing and Binding Regulations prohibit printing of "material which implies in any manner that the government endorses or favors any specific commercial product, commodity, or service.")

See the TYPIST sheet regarding identification of symbols and inclusion of complete bibliographic information.

ILLUSTRATOR

Line Drawings

Supply original pen-and-ink drawings. The publisher will return them if you so request.

Make drawings as small as is practicable.

Prepare for 20% reduction. Maximum area (before reduction) is 16 by 16 inches minus space for caption.

Use 10-point Univers medium, 100-Leroy, or an equivalent size lettering.

Use ticks rather than coordinate lines except where definite values must be read from the curves.

In styling units of measure, use a comma rather than parentheses: TIME, hr rather than TIME (hr).

Use capital letters, except for lowercase letter symbols, isotope abbreviations, and units of measure. Use only an initial capital letter for material within a graph.

Drawings must be completely readable.

Photographs

Supply continuous-tone glossy prints of photographs; screened photographs cannot be reproduced satisfactorily.

Add author's name and figure number in the lower right margin.

Identify the top of photographs where it might not be easily recognized.

Tag photographs that should not be reduced and add crop marks. Maximum size, 6 by 9 inches.

Color photographs are sufficient for color reproduction, but, if you already have color separation negatives, we will use these. You must go by Joint Committee on Printing rules and regulations for color printing (see attached sheets).

2 to be sent when I receive them. EDecca

TYPIST

On a cover page, provide the name and complete address of the author who is to perform the author galley review.

Type all copy double spaced on one side only of 8-1/2 by 11-inch paper, with 1-inch margins.

Include title of paper, name of author, and organizational affiliation of author on the first text page.

Type major headings in capital letters on separate lines; subheadings in capital and lowercase letters on separate lines; subsubheadings in capital and lowercase letters followed by a period and run in with the text. Align all headings with the left margin.

Identify Greek letters and mathematical and other symbols in the margin unless the manuscript is unmistakably clear. Also, where there is likely to be misunderstanding, use and to indicate subscripts and superscripts.

Equations: Number equations and enclose the number in parentheses flush with the right margin.

Figures: Type double spaced a list of the captions for the illustrations.
Fig. 4 Gas-powered blowers on dispersal tower.

Tables: Type each table on a separate sheet.

TABLE 1
Practical Clinical Factors

Procedure	Information supplied	Cost,$
Angiography	High-resolution blood flow	100

References: Cite references in the text by author and date: ...data on insects (Bent, 1977)...data from Jones (1974)...found by Jones, Smith, and Brown (1977)... from other studies (Norris, 1965; Jones, 1972; Smith, 1975). For two publications by the same author published in the same year, use Miller (1973a; 1973b).

List the references alphabetically (by author) at the end of the paper (double spaced, including between the lines of a single reference). Include complete bibliographic information.

Invert the author's name and alphabetize. Arrange more than one work by the same author by date, beginning with the oldest; list the author's name once and then replace it with a 1/4-inch rule. For multiple authors, invert only the first name.

TYPIST (Continued)

French, R. C., 1971, ...
_____, 1973,
_____, and C. D. Evans, 1970, ...

Journal Articles: Author, Year Published, Title of Article, *J. Chem. Phys.*, 22: 1414-1420.

Book: Author, Year Published, *Name of Book*, 3rd ed., pp. 50-58, Publisher, City.

Report: Author, Year Published, *Title of Report*, DOE Report ORNL-300, Oak Ridge National Laboratory, NTIS,

Symposium Proceedings (Note: For symposiums, we need the location and date of the symposium plus the publisher and date of publication for the proceedings.)

Author, Year Published, Title of Paper, in *Analytical Chemistry in Industry*, Symposium Proceedings, Cambridge, Mass., Jan 4, 1969, ... (Complete the reference according to the style for a book, report, or journal).

GUIDELINES FOR PREPARING ENEWETAK TAXONOMIC CHECKLIST

The taxonomic checklist is designed not only to provide a list of accepted names but to present records from Enewetak of the taxa and synonyms previously used. Provision is made to flag new records as well as other special features of selected taxa. We are striving for uniformity in style presentation as given in the points below.

1. Higher taxonomic catagories (Phylum to Family) are arranged from the left margin in descending order, indenting three spaces at each level. These catagories are to be presented in phylogenetic or conventional arrangement, not necessarily alphabetically. Scientific names at these levels are capitalized.

2. Generic, specific and subspecific names are arranged alphabetically. Subgenera are not arranged this way but may be included. These names should be underlined (italicized)

3. Author but not date is to be given for binomial or trinomial names followed by a colon. The only exception is when this is a new record for Enewetak in which case both author and date are given followed by a period.

4. Synonyms are included only when these have been used for Enewetak records. The synonyms are listed after the accepted name with its records. Synonyms are indented three spaces, italicized, and listed alphabetically.

5. Records of taxa from Enewetak include the author name(s) followed by a comma and date. Records are to be presented in <u>chronological</u> order. This applies to both accepted names and synonyms.

6. New Enewetak records[1] are flagged by placing an asterisk (*) next to left side of the generic name.

7. Other footnote marks may be used to indicate special comments about selected taxa. Please use the following marks: first +; second dagger; third ++; fourth double dagger.

DOUBLE SPACE BETWEEN EACH LINE OF CHECKLIST

An example (facsimile) of checklist style is given on the back side of this page.

I hope that a boldface font or other print style can be used to distinguish the accepted name from the synonyms.

---

[1] New records are those which have not been given in published literature previously from Enewetak. Text acknowledgements should give sources other than your own if new records are to be used from unpublished reports or pers. comm. Contributors may opt for a separate Table or Appendix listing collecting records information.

TABLE . Checklist of Enewetak Atoll Echinoderms

Phylum ECHINODERMATA

Class ASTEROZOA

Subclass OPHIUROIDEA

Order CHILOPHIURA

Family OPHIOCOMIDAE

Ophiocoma brevipes Peters: Brooks, 1974; Anderson, 1980.

Ophiocoma dentata Müller & Troschel: Roberts, 1962; Brooks, 1974; Anderson, 1980.

Ophiocoma insularia Lyman: D.L. Clark, 1952; Faust, 1953; D.L. Clark, 1954; Tixson, 1959.

Ophiocoma taylori (Grant): Perkins, 1973.

Ophiocoma erinaceus Müller & Troschel: Brooks, 1974.

* Ophiocoma pusilla Brock, 1888.

Ophiocoma scolopendrina (Lamarck): Roberts, 1962.

Ophiomastix annulosa (Lamarck): Roberts, 1962; Anderson, 1980.

* Ophiomastix caryophyllata Lütken, 1869.

* Ophiomastix palaoensis Murekami, 1942.

+* Ophiomastix venosa Peters, 1854.

Family OPHIONEREIDIDAE

Ophionereis variabilis Bell: Taylor, 1976.

+New Micronesian record (Note to authors - list these footnotes
*New Enewetak record on last page of checklist)

RELEASE AND COPYRIGHT STATEMENTS

Where there is more than one author, one person may assume the responsibility and sign the form.

RELEASE STATEMENT

I authorize the U. S. Department of Energy (DOE) to publish my (our) chapter entitled _____

_____

in the book entitled "The Natural History of Enewetak Atoll." The chapter is unclassified, and there are no patentable items described.

COPYRIGHT STATEMENT

(The author must obtain written permission to quote from or to use illustrations, tables, or other material from copyrighted sources and must provide DOE with copies of all letters granting such permission. He must give DOE a statement to the effect that his book contains no copyrighted material except that for which permission has been obtained.)

To the best of my (our) knowledge the book is

_____ Original and contains no copyrighted material in text, figures, or tables.

_____ Original except for excerpts from copyrighted works that I (we) have specified. In all such cases I (we) have obtained written permission from the holders of the copyrights, and copies of the letters of permission are attached.

_____ _____

Date Signature

SUGGESTED FORM FOR REQUEST FOR PERMISSION TO REPRINT COPYRIGHTED MATERIAL

(DATE)_____

Subject: REQUEST FOR PERMISSION TO REPRINT COPYRIGHTED MATERIAL IN BOOK "THE NATURAL HISTORY OF ENEWETAK ATOLL"

To Whom It May Concern:

I am a contributing author for the subject book, which is to be published by the U. S. Department of Energy.

I request permission to include in my chapter(s) of the book the excerpted material listed below. Appropriate credit will be given to the source of the material.

A self-addressed envelope is enclosed for your convenience.

Sincerely,

(YOUR NAME)_____
(YOUR ADDRESS)_____
_____
_____

Permission is granted to reprint:

Table_____, Table title, Author's name, Title of journal, Volume: Page (Date).

Figure_____, Figure title, Author's name, Name of book, Page, Publisher, Publisher's address, Date.

Text excerpt from . . . .

Signature_____

Title_____

Organization_____

Date_____

BERNICE PAUAHI BISHOP MUSEUM 1889

BISHOP MUSEUM

P.O. BOX 19000-A • HONOLULU, HAWAII 96819 • 808 847-3511

3 March 1983

Dear George,

I enclose instruction for authors of the Enewetak Natural History book. Sorry I forgot to include these before. Also is the recent letter (Feb. 16, 1983) from Janet Lamberson re reptile chapter (Terrestrial) and some mention of her observations on sea Turtles at Enewetak. Can you help her out on id of Typhlops. Please write her regarding the letter. We do not have anyone here who can make the id.

I look forward to your chapter.

Sincerely,

Dennis M. Devaney

Feb 16, 1983

Dear Dennis,

Thanks for your letter and the Foskery, etc. paper. It should surely be included in my plant paper.

I no longer have permission to use the EPA secretary, and as I am no typist, I enclose a cut-and-paste version of the reptile manuscript for you to look at until I can get it typed locally.

We don't have much information on marine reptiles, just one sighting of turtle tracks apparently to a nest, observation of a number of green turtles together in a bay north of Bokolew one time and various sightings of green & hawksbill turtles. We tagged a couple of turtles but never recaptured them. We never saw a sea snake and never heard of one being seen (for sure), and they are not listed for the Marshalls in Dunson, W.A. (ed). Biology of Sea Snakes, in a paper by S.A. Minton, pp. 21-31. Their absence from Enewetak should be noted.

Of special interest in the reptile collection data from BPBM is the record of a blind snake listed as "Typhlopidae" collected in 1980. It is important to know the species. I have neither the experience or reference material to key it out, but would it be possible for

George Balaya or someone at the museum to do it? Typhlops braminus has been introduced to Hawaii (Oliver + Shaw, 1953; Fisher, 1948) and it may have come from there in ornamental plantings. According to Brown (1957) the genus Typhlops is restricted to western Micronesia, and includes only one endemic species T. acutidauda, from Palau. I have to add a paragraph on Typhlops to the ms.

It would also be good to know if the BPBM Emoia and Lipinia spp are Emoia cyanura and Lipinia noctua, as I suspect they are. The checklist would look better.

I can usually be reached at 867-4033 9:30-5:00 except 12:00-1:00, Mon-Fri except Wednesdays. I also work in the lab and library, but am usually in the office or my office mate is. You can leave a message and I can call you ~~back~~ or you can tell me when you will call again, and I will wait for the call.

Aloha,
Janet Lamberson

copy to. E. Reese.

Note: in a

National Museum of Natural History · Smithsonian Institution
WASHINGTON, D.C. 20560 · TEL. 202-

10 January 1983

Ms. Janet O. Lamberson
U.S. Environmental Protection Agency
Marine Science Center
Newport, Oregon 97365

Dear Janet:

Your Enewetak Manuscript was buried in the midst of a hectic field schedule and a major move of my abode out into the suburbs. I return it laden with apologies and with a few suggestions.

For information on potential sea snakes or turtles from Enewetak I can suggest a couple of folks who should know; we have no records in the collection.

Turtles-- Jack Frazier
National Zoological Park
Washington, D.C. 20008

Sea Snakes-- Harold Voris
Reptiles & Amphibians
Field Museum of Natural History
Roosevelt Road at Lakeshore Drive
Chicago, Illinois 60605

I'm off to the West Indies for a short trip and will be in Borneo for February-April. It's my first trip across the Pacific in quite a while, so it should be fun.

Keep in touch and all the best for 1983.

Cheers,

Ronald I. Crombie
Museum Specialist
Division of Reptiles and
Amphibians

pjk

For George-
from Janet

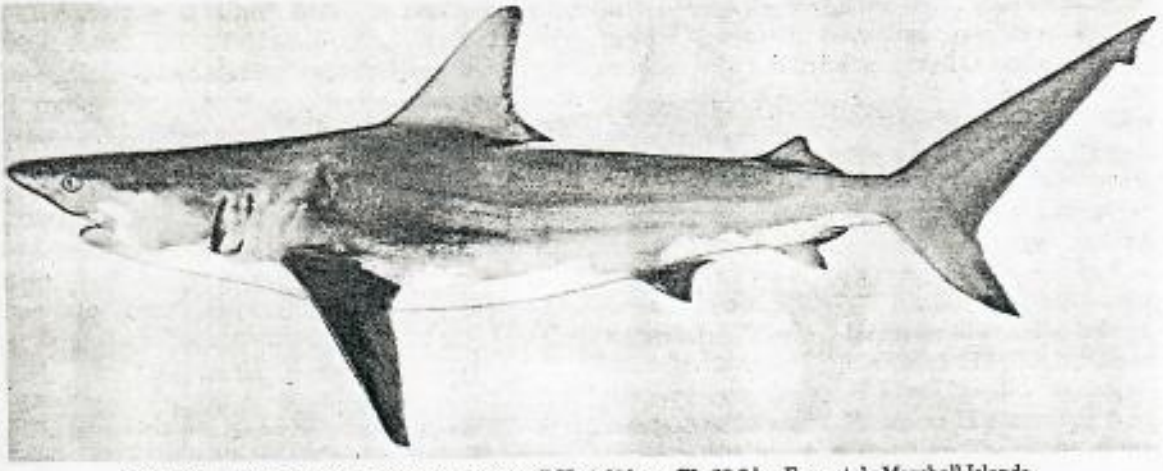


FIGURE 5.—*Carcharhinus limbatus*, 1,415 mm PCL, 1,910 mm TL, 38.2 kg, Enewetak, Marshall Islands.

The tips of the fins of Pacific individuals, particularly adults, are only slightly tipped or edged in black. Also the common Indo-West Pacific *C. melanopterus* has very pronounced black tips on its fins (see Randall and Helfman 1973, fig. 1, 2). To avoid confusion in common names, *C. melanopterus* has been referred to by many recent authors as the blacktip reef shark (though Bass et al. 1973, call it the blackfin reef shark).

Carcharhinus limbatus is distinctive in lacking a median ridge on the back between the dorsal fins, having a relatively long snout, and the cusp of its teeth notably narrow and erect. It has 29-32 upper, 28-32 lower teeth, and 88-102 precaudal vertebrae. The color is gray to bronze on the back, white below, with a long band of the dark dorsal color extending posteriorly from the last gill opening into the pale ventral color as far as the pelvic fins.

Two individuals of *C. limbatus* were caught at Enewetak during the ciguatera survey; these constitute the first records of the species from the Marshall Islands. The head of the illustrated specimen (which was 1,415 mm PCL, 1,910 mm TL, and weighed 38 kg) has been preserved in the Bernice P. Bishop Museum under catalog number 18074.

Only the second specimen, which was about 1,700 mm PCL (original data sheet with measurements was lost), was tested for toxicity. The viscera gave a reaction of 2 when fed to a mongoose.

Bass et al. (1973) reported on 55 of 101 sharks of this species with food in their stomachs. Fifty-one of the sharks had eaten teleost fishes, including: *Scomberomorus commerson*, *S. leopardus*, *Pomadasys* sp., *Sarpa salpa*, *Johnius hololepidosus*, *Leiognathus equula*, *Elops saurus*, *Tilapia mossambica*, and a soleid. Six contained elasmobranchs, including a small *C. obscurus* and a *Rhinobatus annulatus*. Two had eaten *Sepia* sp., and one a spiny lobster, *Panulirus homarus*.

The two Enewetak specimens had empty stomachs.

Galeocerdo cuvier (Peron and Lesueur) (Figure 6): The circumtropical tiger shark is readily identified by its broad bluntly rounded snout, distinctive teeth (heavily serrate, convex on the medial margin, and deeply notched on the lateral), low longitudinal keel on the side of the caudal peduncle, and dark bars (though these tend to fade with age).

The flesh of two tiger sharks from Enewetak, 1,770 and 2,410 PCL (72 and 174 kg), and one from Bikini, 1,498 mm PCL, was tested. None of these sharks were toxic. The Bikini specimen was caught at 4:30 a.m. in only 1.7 m of water.

Bigelow and Schroeder (1948) summarized the literature on food habits, danger to man, etc., of this shark. Other authors such as Clark and von Schmidt (1965), Bass et al. (1975a), and Tester (see footnote 7), have added to the list of the great variety of marine animals (mainly fishes) that this species will take as food, as well as sundry items of garbage and refuse discarded into the sea by man.

The stomach of the largest of the Marshall Islands specimens contained the scutes of a green turtle, *Chelonia mydas*, estimated to be 500 mm carapace length and the bait (a gray reef shark).

Journal of Food Science
March-April
1963
Vol. 23, No. 2

Chemical and Radiochemical Composition of the Rongelapese Diet

DIPTIMAN CHAKRAVARTI AND EDWARD E. HELD
Laboratory of Radiation Biology, University of Washington, Seattle, Washington*

(Manuscript received March 21, 1962)

SUMMARY

The gross chemical composition of the Rongelapese diet indicates that it is low in fat, protein, and ash but fairly high in carbohydrate. The variation in gross chemical composition of the diets examined may be accounted for by the broad variability of the different diets. The habitat of the Rongelapese probably does not demand a high-energy diet, which may partially justify the lower fat intake. Levels of calcium and phosphorus seem below the minimum required for maintenance of a proper calcium-phosphorus balance. The diet seems adequate in magnesium and potassium but slightly low in sodium. The nickel, cobalt, and copper contents seem high in the Rongelap rations, manganese content is low, and iron and zinc compare favorably with minimum daily requirements.

Hight levels of cobalt-60 and zinc-65 are associated with each other and with rations containing local fish. The higher levels of strontium-90 and cesium-137 are found where local fruit was consumed. Coconut contributes little strontium-90, and pandanus the most. Rations with higher zinc-65 also contain higher levels of stable zinc, indicating that local sea foods may be the main source of zinc in the diet. Cesium-137, strontium-90, and cobalt-60 show no definite correlation with stable potassium, calcium, and cobalt, respectively. There is probably a net addition of minerals to Rongelap soils from imported foods.

INTRODUCTION

Rongelap Atoll was contaminated with radioactive fallout resulting from the Bravo test on March 1, 1954, to the extent that the population of 82 Rongelapese had to be evacuated. Some 200 Marshallese returned to Rongelap in June, 1957, after the area had been declared again safe for human habitation. Since 1954 several surveys have determined levels of radioactive contamination at Rongelap Atoll (Dunning, 1957). In March, 1958, a study of the ecology of the atoll relative to radioactive contamination was initiated at the request of the U. S. Atomic Energy Commission, Division of Biology and Medicine.

One of the objectives of the present investigation was to determine the amount and kinds of radionuclides and minerals ingested by the Rongelapese through foods. Fat, protein, and carbohydrate were determined to provide a basis of comparison with known diets. To our knowledge there are no published data on the diet of the Rongelapese.

Rongelap Atoll lies in the northern Marshall Islands, an area of comparatively low rainfall and limited variety of agricultural products. The principal plants eaten are coconut, breadfruit, pandanus, and the arrowroot, or tacca; some squash and papaya are also grown. Bananas and taro have been introduced but are not yet in full production.

Fish, clams, langusta, birds, chickens, and pigs are eaten. Of these, the most important is fish. The coconut crab, *Birgus latro*, is considered a delicacy but is the one food item excluded from the diet because of the strontium-90 content (Dunning, 1957).

The coconut, "Ni" in Marshallese, is eaten at different stages of development. The juice

*Operated by the University of Washington under Contract No. AT (45-1) 1385 with the United States Atomic Energy Commission.

from the immature nut is preferred for drinking, and only rarely is the germinated nut eaten. Copra, the dried coconut meat, is a staple eaten alone or mixed with other foods.

The coconut sap is collected from the cut ends of inflorescences of coconut trees set aside for this purpose in the village area. The fresh sap is partaken of by all age groups, and the fermented sap, "jekro" or "jugaroo," is consumed by adults.

Breadfruit (Ma) is eaten either baked or boiled, and also is made into a preparation referred to as "cheese." To make "cheese," the skin is removed and the pulp is placed in salt water for three days, then wrapped in breadfruit leaves and buried in the sand for at least one week before it is eaten. The Rongelapese claim that this "cheese" will keep two years or more in the sand.

Pandanus (Bop) is eaten fresh, boiled, or baked. "Jenkun," a preparation said to keep for more than five years, is prepared by baking or boiling the Pandanus keys and scraping out the pulp. The pulp is dried, usually on sheet metal, over coals until it reaches the consistency of fudge. The dried pulp is pressed into a roll and wrapped in Pandanus or coconut leaves. Slices are cut off as needed.

Tacca or arrowroot (Mokmok) tubers are washed with sea water, crushed and passed through a sieve into a pan of sea water, and allowed to settle for three or four hours. When the starch begins to coagulate, the water is decanted. Sea-water washes are repeated several times, followed by one fresh-water wash. Finally the starch is dried and stored as a powder. The powder is mixed with water for use, and either eaten immediately as prepared or boiled or baked.

The papaya is eaten fresh, sometimes mixed with rice or grated coconut.

The fish consumed are primarily reef fish such as the goatfish, *Mulloidichthys* sp., mullet, *Neomyxus* sp., surgeon-fish, *Acanthurus* sp., and the siganids. The fish are eaten baked, boiled, or raw. The three fish we have observed the Rongelapese to eat raw are goatfish, muliet, and siganids. Fish are also preserved by baking and then drying in the sun. Sometimes salt is added before the fish are dried.

The langusta, spiny lobster, is eaten boiled. The clams are either boiled as a chowder or baked in the shell in a covered pit. The clam meat is sometimes also dried in the sun after baking and kept for several days.

Birds are eaten either baked or boiled, and are also dried following precooking. Bird eggs, usually hard boiled, form only an incidental part of the diet; they are used principally when the Rongelapese are visiting islands other than their main island or nearby Ailinginae Atoll.

Pig and chicken are eaten primarily on special occasions.

The source of fresh water in the area is cisterns. Ground water, though potable in certain areas during the rainy season, is not ordinarily drunk.

Of the imported foods, rice, wheat flour, and canned corned beef appear to be the most important. Many other products are imported from time to time, such as sardines, C-ration, ship's biscuit, and candy. In 1958 large quantities of C-rations were consumed. Many individuals prefer the imported foods.

MATERIALS AND METHODS

The samples were collected during a single 24-hr period in September, 1959, at Rongelap Island, taking care that the composition and the amount corresponded to the composition and amount actually eaten by the individual. (Bwio Soap, former village secretary, and Neil Morriss, Trust Territory Resident Agriculturist at Rongelap Atoll at that time, or one of the authors collected each sample.) Wet weights of the samples were taken in the field. The samples were then dried at 90°C and shipped to the University of Washington, Seattle.

Caution must be used in collecting to be reasonably sure that such daily rations are a true representation. Misunderstanding and a misguided desire to please can easily lead some Rongelapese to provide merely a collection of miscellaneous food items rather than actual daily rations of prepared food. It was felt that a few samples composed of items and portions actually seen to be consumed were preferable to many samples of uncertain origin. Consequently, some samples proffered by individuals were discarded.

Even so, there are obvious discrepancies. Sample number 3 (Table 1), for example, appears to be ridiculously low in the total amount consumed. Doubtless there must have been some "snacking," but the eating habits of the Rongelapese are irregu-

Table 1. Description o
Rongelap Island in Sept
is a 24-hr ration).

Sample no.	Description
1	a) Pandanus past rice and bake (mixed) b) Partly baked b with bully be c) Bully beef sand
2	a) Coconut meat (b) Pandanus "pie" c) Baked fish d) Sardines, canne e) Boiled rice w/c
3	a) Breadfruit, bak b) Coconut and br baked c) Bread d) Bully beef e) Ship's biscuit f) Rice w/coconu boiled
4	a) Coconut, ripe b) ½ papaya c) Rice and fish mi d) Bread, local (c milk, not save
5	a) Rice and fish mi b) Bread, local c) Rice
6	a) Breadfruit, bake b) Coconut w/bak c) Fish, baked d) Bread, local e) Coconut, entire f) Rice, boiled g) Sardines, canne
7	a) Pandanus keys, b) Goatfish, baked c) Sardines, canne d) Rice, boiled
8	a) Fish, baked b) Bread, local c) Bully beef d) Sardines, canne e) Rice, boiled
9	a) Rice and fish mi b) Rice and fish mi

Table 1. Description of food rations collected at Rongelap Island in September, 1959 (each sample is a 24-hr ration).

Sample no.	Description	Wet wt. (g)	Total dry wt. (g)
1	a) Pandanus paste, boiled rice and baked fish (mixed)	253	374.68
	b) Partly baked bread dough with bully beef	252	
	c) Bully beef sandwiches	195	
2	a) Coconut meat (green)	30	175.85
	b) Pandanus "pie"	16	
	c) Baked fish	23	
	d) Sardines, canned	20	
	e) Boiled rice w/coconut milk	249	
3	a) Breadfruit, baked	41	87.12
	b) Coconut and bread dough, baked	24	
	c) Bread	31	
	d) Bully beef	17	
	e) Ship's biscuit	13	
	f) Rice w/coconut milk, boiled	49	
4	a) Coconut, ripe	72	321.69
	b) ½ papaya	57	
	c) Rice and fish mixed	306	
	d) Bread, local (coconut milk, not saved)	81	
5	a) Rice and fish mixed	243	203.16
	b) Bread, local	80	
	c) Rice	197	
6	a) Breadfruit, baked	203	484.10
	b) Coconut w/baked dough	203	
	c) Fish, baked	126	
	d) Bread, local	75	
	e) Coconut, entire	50	
	f) Rice, boiled	291	
	g) Sardines, canned	154	
7	a) Pandanus keys, raw	115	314.90
	b) Goatfish, baked	26	
	c) Sardines, canned	101	
	d) Rice, boiled	721	
8	a) Fish, baked	155	440.50
	b) Bread, local	145	
	c) Bully beef	66	
	d) Sardines, canned	94	
	e) Rice, boiled	622	
9	a) Rice and fish mixed	421	262.30
	b) Rice and fish mixed	64	

lar and it was impractical to follow each individual throughout the day. Therefore, all of the samples collected (Table 1) should probably be considered as erring toward the low side for total consumption. However, there does appear to be a reasonable agreement with quantities listed by Murai (1954) from a study at Majuro Atoll. Catala (1957) pointed out the difficulties of obtaining quantitative data in these areas.

The components of each sample were dried to constant weight in the laboratory at Seattle (Table 1). The entire diet for each individual was then homogenized in water with a high-speed blender, dried at 98°C, and pulverized to a fine powder. Subsamples of the powder were taken for fat, protein, carbohydrate, and radiochemical analyses. Portions weighing 40–250 g were wet-ashed with HNO_3 and H_2O_2, and the ash dried in 250-ml beakers for gamma-ray spectroscopy.

The gamma-counting equipment consisted of a 3-in. thallium-activated sodium iodide crystal used in conjunction with a 256-channel analyzer with a digital print-out. The total counts per minute under the photopeak were calculated by summing counts per minute of all channels included in the peak and subtracting the background counts. The counting efficiency for the gamma energies measured was determined by calibrating the instrument with standards with an error of ± 10%.

Following analysis by gamma spectroscopy, the ashed samples were dissolved in a known volume of 1*N* HNO_3. Strontium-90 was determined on an aliquot by the method of Kawabata and Held (1958), in which a combination of nitric acid precipitation and ion-exchange procedures is used.

Calcium was determined by permanganate titration of oxalic acid and confirmed by flame spectrophotometry, with the internal standard technique of Chow and Thompson (1955). Potassium was determined by flame spectrophotometry at 766-mμ wavelength, and independently confirmed with estimation of potassium by titration of the cobaltinitrite with potassium permanganate (Hibbard and Stout, 1933). Sodium was determined at 589-mμ wavelength. The standardization procedure and general function of the system have been described by Chakravarti and Joyner (1960).

In determining magnesium, an aliquot of the ashed sample was dissolved in 0.1*N* HCl and the solution passed through a Dowex-50 X8 100-200 resin column of precalculated capacity. Interfering anions were removed by elution with two-column volumes of distilled water. The resin was then stripped of cations with three-column volumes of 2*N* HCl, and the eluate was neutralized to methyl orange with concentrated NH_4OH. Calcium was removed by precipitation with ammonium oxalate followed by boiling and filtration. The filtrate was

Table 2. Composition of rations from Rongelap Island (dry-weight basis).

Constituent		Sample no. 1	2	3	4	5	6	7	8	9
Proximative analyses (%)										
Moisture		46.5	48.0	50.2	37.7	60.9	59.7	67.3	59.3	45.9
Fat		3.73	1.64	1.35	1.34	4.35	8.47	2.80	3.60	2.82
Protein		15.1	10.7	11.6	9.65	7.65	23.7	14.5	25.9	8.65
Carbohydrate		30.5	37.8	32.7	49.2	21.3	3.57	10.9	6.98	38.9
Ash		4.17	1.87	4.13	2.19	5.83	4.62	4.54	4.28	3.71
Chemical composition										
Calcium	mg/g	0.761	0.593	0.920	0.571	0.381	2.13	1.29	0.624	0.455
Magnesium	mg/g	0.804	0.797	1.13	0.938	0.777	1.10	0.657	0.760	0.814
Sodium	mg/g	3.42	2.44	6.20	1.97	2.59	4.57	7.32	3.22	2.77
Potassium	mg/g	2.28	1.39	3.12	3.34	1.12	4.60	2.55	2.95	1.52
Phosphorus	mg/g	0.134	0.061	0.024	0.119	0.056	0.358	0.203	0.823	0.102
Nitrogen	mg/g	24.2	17.1	18.5	15.5	12.3	37.8	23.9	41.3	13.8
Nickel ppm	(mg/kg)	0.0	24.	4.6	1.7	33.	5.4	25.	3.2	1.7
Manganese	(mg/kg)	.71	1.0	.22	2.7	2.5	2.9	3.3	2.2	1.7
Cobalt	(mg/kg)	2.1	.80	.30	.63	.00	.27	.33	.12	.29
Copper	(mg/kg)	14.	27.	8.9	20.	5.6	22.	7.5	6.8	2.8
Iron	(mg/kg)	66.	69.	44.	34.	33.	47.	33.	71.	29.
Zinc	(mg/kg)	24.	14.	16.	13.	16.	48.	37.	41.	29.

Table 3. Composition of rations for a 24-hr period from Rongelap Island.[a]

Constituent		Sample no. 1	2	3	4	5	6	7	8	9
Wet wts.	(g)	700.0	338.0	175.0	516.0	520.0	1201.0	963.0	1082.0	485.0
Moisture	(g)	325.	162.	87.9	194.	317.	717.	648.	641.	223.
Fat	(g)	14.0	2.88	1.17	43.2	8.84	41.0	8.82	15.8	7.38
Protein	(g)	56.6	18.8	10.1	31.0	15.5	114.	45.5	114.	22.7
Ash	(g)	15.6	3.29	3.59	7.06	11.8	22.4	14.3	18.8	9.74
Carbohydrate	(g)	288.	151.	72.3	240.	167.	306.	246.	292.	222.
Calcium	(g)	0.285	0.104	0.080	0.184	0.077	1.03	0.407	0.275	0.119
Magnesium	(g)	0.301	0.141	0.088	0.302	0.158	0.531	0.207	0.335	0.214
Sodium	(g)	1.28	0.429	0.540	0.634	0.526	2.21	2.30	1.42	0.727
Potassium	(g)	0.854	0.244	0.272	1.07	0.228	2.23	0.803	1.30	0.399
Phosphorus	(g)	0.036	0.012	0.002	0.038	0.011	0.173	0.064	0.080	0.027
Nitrogen	(g)	9.06	3.00	1.61	4.99	2.49	18.3	7.52	18.2	3.62
Nickel	(mg)	0.0	.91	.40	.51	6.7	2.6	7.7	1.4	.45
Manganese	(mg)	.27	.18	.02	.86	.50	1.4	1.0	.99	.45
Cobalt	(mg)	.78	.14	.03	.20	0.0	.13	.10	.05	.07
Copper	(mg)	5.3	4.7	.77	6.3	1.1	11.	2.4	3.0	.73
Iron	(mg)	25.	12.	3.9	11.	6.7	23.	10.	31.	7.5
Zinc	(mg)	8.9	2.4	1.4	4.3	3.2	23.	12.	18.	7.7

[a] Calculated from Table 2, wet-to-dry ratio, and weight of total sample.

Table 4. Radioisotopes (disintegrations per minute per gram) in rations from Rongelap Island (dry-weight basis).

Sample no.	Co^{60}	Zn^{65}	Mn^{54}	Ca^{137}	Sr^{90}
1	0.35 ± .12[a]	0.40 ± 0.29	−0.04 ± 0.09	61.4 ± 0.60	0.84 ± 0.07
2	0.52 ± .25	−1.03 ± 0.53[b]	0.11 ± 0.20	14.1 ± 0.50	1.63 ± 0.16
3	0.12 ± .52	−2.40 ± 1.0	−0.49 ± 0.39	21.1 ± 0.87	1.25 ± 0.25
4	0.23 ± .13	−0.76 ± 0.28	−0.07 ± 0.10	17.6 ± 0.38	0.43 ± 0.06
5	0.43 ± .22	−0.67 ± 0.45	−0.11 ± 0.16	3.6 ± 0.28	0.21 ± 0.09
6	0.90 ± .13	1.70 ± 0.30	−0.23 ± 0.09	16.1 ± 0.29	0.66 ± 0.06
7	0.56 ± .14	0.87 ± 0.35	−0.19 ± 0.10	20.0 ± 0.38	0.86 ± 0.08
8	1.20 ± .15	2.50 ± 0.41	−0.21 ± 0.11	3.0 ± 0.17	0.22 ± 0.05
9	0.33 ± .16	0.05 ± 0.36	−0.003 ± 0.13	2.6 ± 0.21	0.32 ± 0.08

[a] 0.95 counting error.
[b] Negative values are given to indicate that there are errors in addition to the counting error which cannot be specifically accounted for.

made basic with 1*N* NH_4OH; 5% $(NH_4)_2PO_4$ was added until a precipitate formed, and an excess of NH_4OH was then added during constant stirring. The precipitate, magnesium ammonium phosphate, was allowed to settle overnight, removed by filtering, dissolved in 6 drops of concentrated H_2SO_4, and made to volume with water. Magnesium was determined by titrating an aliquot of this solution against a standard EDTA solution using the indicator Eriochrome Black T.

Total phosphorus was determined by the colorimetric method of Fleischer *et al.* (1958).

The transition elements nickel, manganese, cobalt, copper, iron, and zinc were determined colorimetrically by methods described by Sandell (1959). The elements were initially separated by selective elution of their chloride complexes from an anion-exchange resin. Kraus and Moore (1953) have shown that the chloride complexes of the transitional elements nickel through zinc are adsorbed onto a strongly basic anion-exchange resin (Dowex 1) and are selectively eluted at different molarities of HCl. Following the same principle, Joyner and Chakravarti (1960) suggested techniques that were applied to these samples.

Protein nitrogen was determined by the Kjeldahl method.

Fat was determined by a modification of the Johnson method (Winton and Winton, 1945). Methylene chloride was the extracting solvent.

Ash content was determined as the nitrate form by drying an aliquot of the ashed sample to constant weight.

Moisture content was calculated from the wet-weight to dry-weight ratio.

Total carbohydrate and like substances were estimated by subtracting moisture, fat, protein, and ash from the total solids and calculating the carbohydrate content by difference.

RESULTS AND DISCUSSION

Table 1 lists the components of the 24-hr food rations collected at Rongelap Island. Tables 2 and 3 show proximate composition and trace-element content of the rations, and Tables 4 and 5 present levels of radioisotopes. Results are given on a percentage or unit weight basis (Tables 2 and 4) and as amount for total diet (Tables 3 and 5). The former basis permits comparison of the relative composition of individual rations and facilitates evaluation of the contributions made by specific items in each diet; the latter basis shows the actual amounts consumed in a 24-hr period.

In evaluating the chemical constituents consumed by an individual in a 24-hr period, the gross weight of the total diet is of much importance. By comparing the proximate chemical composition on a percentage basis with the published chemical composition of some of the items constituting the samples, it is possible to account for the variation in moisture, fat, protein, carbohydrate and ash content of the different diets.

Since information on the nutritional aspects of the Rongelapese diet is limited, comparison of the data with data for other areas is probably not meaningful. The gross percentage composition indicates that the diets are generally low in fat, protein, and ash but fairly high in carbohydrate content.

When the data in Table 3 are compared with the recommended daily dietary allowances published by the Food and Nutrition Board of the National Research Council, the

24-hr rations of the Rongelapese appear to be generally below the level recommended for protein. Since fat allowances are based more on food habits than on physiological requirements, no definite conclusion can be drawn about the apparent low fat content of these diets. The habitat of the Rongelapese probably does not demand a high-energy diet, which may partially justify the lower fat intake.

The calcium content of the 24-hr ration seems to be much lower than the suggested normal requirement (Nutritional Data, 1958). On the same basis, the magnesium levels seem to be adequate but the phosphorus levels are far below what is necessary to maintain a proper calcium-phosphorus balance in a good diet. The sodium levels appear to be slightly below the normal suggested intake levels, although no information is available as to the minimum daily requirement of sodium. The potassium level is lower than the sodium content, which is generally the case in most diets.

Kent and McCance (1941) have suggested that an ordinary adult diet will supply 0.3–0.5 mg of nickel daily. On the basis of these values, the nickel content of the 24-hr Rongelapese rations appears to be higher than usual in some cases. Nickel salts frequently gain access to food from corrosion of nickel vessels, and small quantities of nickel may also be found in various manufactured foods. It also may be that some of the native food components are high in nickel content.

Basu and Malakar (1940) have suggested that 4.6 mg of manganese are required per day to keep an adult male in manganese balance. On this basis, the Rongelapese food appears to be low in manganese. The average adult diet of good quality supplies 0.005–0.008 mg of cobalt daily (Harp and Scoular, 1952); in comparison the Rongelapese food appears to be fairly high in cobalt content. Tomsett's (1934) balance experiments with adult humans indicate a minimum copper requirement as low as 0.6 mg daily. The estimate of Chou and Adolph (1935) is 1–2 mg daily. The Rongelapese diet is definitely above the experimental minimum requirements given. The iron in the diet appears to compare favorably with the minimum daily requirement as suggested by the National Research Council. Eggleton (1939) has given normal daily food intake of zinc as 12 mg. The Rongelapese food appears to have large variation in zinc content, and on the average is less than 8 mg daily.

The higher levels of cobalt-60 and zinc-45 are associated with each other and with rations containing local fish. This is to be expected since these isotopes are found primarily in marine organisms (Dunning, 1957). The higher levels of strontium-90 and cesium-137 are found where local fruit was consumed. In general, higher levels of strontium-90 are coincident with higher levels of cesium-137. Coconut contributes little strontium-90, and pandanus the most.

The average value for the daily intake of strontium-90 is 83 $\mu\mu$c, and for calcium 0.28 g. The average daily intake in terms of "strontium units" ($\mu\mu$c Sr^{90}/g Ca) is then nearly 300. This value is about three

Table 5. Radioisotopes in 24-hr rations from Rongelap Island.[a]

Sample no.	$\mu\mu$c/24 hr				
	Co^{60}	Zn^{65}	Cs^{137}	Sr^{90}	$\mu\mu$c Sr^{90}/g Ca
1	59 ± 20[b]	67 ± 49	10000 ± 100	142 ± 11.8	497 ± 41.4
2	42 ± 20		1100 ± 40	129 ± 12.7	1239 ± 121.6
3			830 ± 34	49 ± 9.8	613 ± 122.5
4	33 ± 19		2600 ± 55	62 ± 8.7	339 ± 47.3
5	39 ± 20		330 ± 26	19.2 ± 8.2	248 ± 106.5
6	200 ± 48	370 ± 65	3500 ± 63	144 ± 13.1	140 ± 12.7
7	79 ± 20	120 ± 50	2800 ± 54	122 ± 11.4	300 ± 27.9
8	240 ± 30	500 ± 82	590 ± 34	43.6 ± 9.9	159 ± 36.1
9	39 ± 19		310 ± 25	37.8 ± 9.5	331 ± 82.8

[a] Calculated from Table 4, wet-to-dry ratio, and weight of total sample.
[b] 0.95 counting error.

times that of previous estimates (Dunning, 1957; Cohn *et al.*, 1960). Those estimates were based on an estimated daily intake of 0.8 g of calcium, or about three times the value reported here. Thus, the significant difference between this and previous values reflects a discrepancy between observed and estimated calcium intake. It is not within the scope of this report to enter into an estimation of body burden, which has been discussed in detail by Cohn *et al.* (1960). However, it is of interest to note that the body burden as estimated from urinalysis data (Woodward *et al.*, 1959) and discussed by Cohn is consistent with a discrimination factor of four and a daily intake of about 100 $\mu\mu$c Sr^{90}/g calcium. This would indicate either that the discrimination factor is greater than four or that these samples do not correctly represent daily calcium intake. In any case, it is obvious that continued study of Sr^{90} movement at Rongelap Atoll is necessary.

Rations containing the higher levels of zinc-65 also contain the higher levels of stable zinc, indicating that local sea foods may be the main source of zinc in the diet. Cesium-137, strontium-90, and cobalt-60 show no definite correlation with potassium, calcium, and cobalt, respectively, indicating that these elements are in large measure supplied from imported foods.

With the current means of sanitation—pit toilets and burial of garbage—on Rongelap and Eniaetok Islets there must be a net addition of minerals. The chief export, copra, is low in ash content as compared with imported foods. A quantitative evaluation of the addition would require comparison of export and import records.

REFERENCES

Basu, K. P., and M. C. Malakar. 1940. Iron and manganese requirements of the human adult. *J. Indian Chem. Soc.* **17**, 317.

Catala, Rene L. A. 1957. Report on the Gilbert Islands: Some aspects of human ecology. Atoll Research Bulletin No. 59. The Pacific Science Board. National Academy of Sciences, National Research Council, Washington, D. C. 197 pp.

Chakravarti, D., and T. Joyner. 1960. Potassium as an index of naturally occurring radioactivity in tuna muscle. *Trans. Am. Fisheries Soc.* **89**, 312.

Chou, T. P., and W. H. Adolph. 1935. Copper metaholism in man. *Biochem. J.* **29**, 476.

Chow, H. J., and T. G. Thompson. 1955. Flame photometric determination of calcium in sea water and marine organisms. *Anal. Chem.* **27**, 910.

Cohn, S. H., J. S. Robertson, and R. A. Conard. 1960. Radioisotopes and environmental circumstances: The internal radioactive contamination of a Pacific island community exposed to local fallout. A symposium on radioisotopes in the biosphere. Richard S. Caldecott and Leon A. Snyder, eds. University of Minnesota Printing Department, p. 306.

Dunning, G. M. 1957. Radioactive contamination of certain areas in the Pacific Ocean from nuclear tests. U. S. Atomic Energy Commission report, U.S. Government Printing Office, Washington, D. C.

Eggleton, W. G. E. 1939. The zinc content of epidermal structures in beriberi. *Biochem. J.* **33**, 403.

Fleischer, K. D., B. C. Southworth, J. H. Hodecker, and M. M. Tuckerman. 1958. Determination of phosphorus in organic compounds. Rapid micro and semi-micro method. *Anal. Chem.* **30**, 152.

Harp, M. J., and F. I. Scoular. 1952. Cobalt metabolism of young college women on self-selected diets. *J. Nutrition* **47**, 67.

Hibbard, P. L., and P. R. Stout. 1933. The estimation of potassium by titration of the cobaltinitrite with potassium permanganate. *J. Assoc. Offic. Agr. Chemists* **16**, 137.

Joyner, T., and D. Chakravarti. 1960. The analysis of some trace elements in fish tissues. U. S. Atomic Energy Commission report No. UWFL-68. Laboratory of Radiation Biology, University of Washington. 14 pp.

Kawabata, T., and E. E. Held. 1958. A method for the determination of strontium-90 in biological materials. Applied Fisheries Laboratory (now Laboratory of Radiation Biology), University of Washington. Unpublished.

Kent, N. L., and R. A. McCance. 1941. The absorption and excretion of "minor" elements by man. 2. Cobalt, nickel, tin and manganese. *Biochem. J.* **35**, 877.

Kraus, K. A., and G. E. Moore. 1953. Anion-exchange studies. VI. The divalent transition elements manganese to zinc in hydrochloric acid. *J. Am. Chem. Soc.* **15**, 1460.

Murai, Mary. 1954. Nutrition study in Micronesia. Atoll Research Bulletin No. 27. The Pacific

Science Board, National Academy of Sciences, National Research Council, Washington, D. C. 239 pp.

"Nutritional Data." 1958. 3rd ed. H. J. Heinz Company, Pittsburgh, Pennsylvania.

Sandell, E. B. 1959. "Colorimetric Determination of Traces of Metals." 3rd ed. 1032 pp. Interscience Publishers, New York.

Tompsett, S. L. 1934. The copper content of blood. *Biochem. J.* **28**, 1544.

Winton, A. L., and K. B. Winton. 1945. "The Analysis of Foods." 999 pp. John Wiley and Sons, New York.

Woodward, Kent T., Ariel G. Schrodt, James E. Anderson, Harry A. Claypool, and James B. Hartgering. 1959. The determination of internally deposited radioactive isotopes in the Marshallese people by excretion analysis. Proc. of Hearings of Joint Committee on Atomic Energy, 86th Congr., First session on fallout from nuclear weapons tests. Volume 2, p. 1329.

The Prote

General Dy

Freeze-dried
7.5% crude fat;
crude fiber; 2.6
tein was 86%;
fiber, 15%. Th
favorably with
was 2.90, which
PER of casein w
The rats were fe
tained all essent
Available energy

For extended explora
system must be designe
astronaut needs as air r
disposal, water recovery
From a logistic standpoin
vide an ideal gas-exchang
of their capability to conv
lar constituents while pr
thermore, treated waste m
mineral nutrients and wat
growth.

Before algae can be a
food, the nutritional cha
product, grown by mass-
must be evaluated. Th
strain of *Chlorella* 71105
extensive research in con
tosynthetic gas exchange
tional studies with this st
complete, the following st
taken: 1) composition, i.e
ysis, vitamins, minerals,
2) digestibility of protein,
and crude fiber; 3) quali
caloric value.

[a] The work reported was ca
tract No. AF 33(616)-7373,
tory, Aerospace Medical Lab
Force, Wright-Patterson Air

a background to these. The urgency of the issue of conservation in these islands is obvious to anyone who sees this film with an appreciative eye. It features the Charles Darwin Research Station at Academy Bay, center for active and continuing research on the biology of the Galapagos.

Of immense interest to reef ecologists is the film entitled "The Coral Gardens of Shadwan," made by Helmut and GUnther Fleissner, of the Zoological Institute of the University of Frankfurt, Germany. This film was made on coral reefs in the Red Sea and not only shows beautiful reefs, but details of ecological processes and relationships, even including zooxanthellae in the cells of the corals. We hope to have an article on this film and the details of how it was made from Mr. GUnther Fleissner, with whom we had the privilege of a visit.

ORIGINAL OBSERVATIONS

TOXOPLASMOSIS ON CAROLINE ATOLLS

by G. D. Wallace
Pacific Research Section, NIAID, P.O. Box 1680,
Honolulu, Hawaii 96806

The epidemiology of toxoplasmosis was investigated on three remote and ecologically simple atolls in the western Pacific. The atolls, Eauripik, Ifalik, and Woleai, are located within 80 miles of each other but travel between them and contact with the outside world is infrequent. The Micronesian residents share the same culture, types of food, and similar environment in general. The prevalence of human infection, as measured by the presence of dye-test antibodies, was high on Ifalik, moderate on Woleai, and nearly absent on Eauripik. On Ifalik and Woleai, there was also serologic evidence of infection in rats, the only wild mammal present, and in the domestic animals, including cats, dogs, and pigs. On Eauripik, however, rats and cats had not become established and the dogs and pigs were serologically negative, except for one dog that had been imported from Woleai. Cats or rats appeared to be the most likely reservoir of Toxoplasma in the atolls. The consumption of raw meat did not appear to be an important source of human infection. (Abstract of a detailed account to appear in an early number of the American Journal of Epidemiology.)

OBSERVATIONS ON THE GREEN TURTLE IN THE MARSHALL ISLANDS

by F. R. Fosberg

Several workers interested in the breeding habits of the green turtle (Chelone mydas (L.)) have suggested that I publish certain observations made in the course of field work in the Marshall Islands

in 1951 and 1952. Turtles were observed to come ashore on Jemo Island during a visit to this island December 18-22, 1951 and on Bikar Atoll during a visit from August 6-12, 1952. Since my observations do not agree in every particular with those of others made in different parts of the world, it seems worthwhile to place them on record in detail.

Jemo is a tiny islet on a small segment of reef, with no lagoon, nor even a pond, located at 10°08' N, 169°32' E, in the northern Marshall Islands, between Likiep and Ailuk atolls. The islet is flat, partly covered by a coconut plantation, with thick forest around part of the periphery and scrub around the rest. Part of the shore is coral sand beach, part beachrock, and part a rough erosion ramp. Back of the shore the ground is largely coral sand.

Shortly after our landing I walked around the beach and counted 44 turtle tracks, indicating that in the past several days 22 turtles had crossed the beach from the sea to the sandy ground at the edge of the vegetation, then recrossed it back to the sea. Usually, at the edge of, or just inside, the vegetation, was a shallow pit about a meter across, with a low pile of sand at one side, thrown out of it. I assumed that the clutch of eggs would be buried in the bottom of the pit, and dug in the bottom of a number of the freshest of them. In each case undisturbed roots were found a little below the bottom. In one case I finally located the eggs, 106 of them, in the bottom of a smaller hole located under the broad pile of sand that was thrown out of the larger pit. The hole had been about 60 cm deep and 30 cm across, straight sided, with sand packed back in it on top of the eggs. The eggs were spherical, about the size and appearance of ping-pong balls, white, with a smooth, dull surface and a translucent spot on one side, where the yolk rested. The shells were only slightly calcified, denting on contact with other eggs or with fingers. The whites were completely non-viscous, clear, and did not coagulate on cooking. The yolks were yellow and soft, and when cooked scrambled, they resembled a cheese omelette or an overcooked welsh rabbit, in both taste and consistency.

At 2 a.m. on the 19th I went out and scouted the beach. The moon was full and the tide low. There were only 2 new tracks, and the turtle that made them was found, heading as rapidly as she could scramble back toward the sea. I turned her over to be photographed in the morning. She struggled for a while, then calmed down, emitting a sighing "ah'h" sound, with tears running from her eyes. Next morning she was lying quietly, but struggled violently when disturbed. After she was measured and photographed she was released and lost no time in reaching deep water. She was mottled dark olive-drab above, yellowish below, measured 75 cm across and 120 cm long, from tip of tail to tip of beak with head drawn in, was quite heavy to turn over, but was not weighed. The mouth was a hard triangular beak with sharp jagged edges. She made no attempt to bite. Her front flippers were long and broadly sword-shaped, the hind ones short and broadly spatulate, the tail short and triangular.

Bikar Atoll is a small atoll, with three principal islets and a small sand bank, on a reef around a lagoon, lying at 12°15' N, 170°05' E,

the next to the northernmost of the Marshall Group. Bikar Islet, the largest of the three, is of sand, except for areas in the interior where this has been cemented into phosphate rock. On the western and southern coasts are sand flats with rather open vegetation much frequented by turtles as nesting sites. An outstanding feature of these parts, especially on the south coast, is the way the sand has been churned up by turtles digging holes in it. On the afternoon of August 6 I counted 596 tracks. That night 6 more turtles came ashore, of which 3 were seen by the party. One was measured, being 70 cm across and 135 cm long. She was strong enough to move on land with a small man sitting on its back. When caught she shed tears. When released she headed back to sea, climbing over very rough pitted rock remnants with some difficulty, but successfully. A few turtles came ashore on each of the following five nights, on August 10 about 15. On August 11 three were seen, but probably more came ashore. One night one blundered through our camp, creating much havoc. One that was spotted coming out of the water was frightened by the light and turned back. Two more turtles were measured, one being 80 cm wide and 122.5 cm long, the other 70 cm wide and 115 cm long. Colors and patterns on shells were most varied.

more photographs?

I watched one come ashore at 8:10 p.m., August 11, before the moon rose. She walked about 50 m inland, poked her front end into a large Scaevola bush, stopped and began to scratch with her hind feet, gradually excavating a hole less than 30 cm across and as deep as the short hind flippers could reach, using a peculiar back-hand scooping motion with alternate feet, each time, while digging with one foot, flipping away the sand that was brought up by the other foot previously. This appeared to be a very inefficient method of digging. When the hole was finished the rear end of the turtle projected over the hole and the tail pointed downward. Eggs were expelled 1-2 or even 3-4 at a time, dropping into the hole. This turtle laid 92 eggs, taking 11 minutes for the actual laying process. Then she filled the hole very carefully with sand, which she patted and pressed down in a mound over the eggs. Gradually she spread this mound out and covered it with dead leaves, then dug a pit to one side and threw the dirt over the hole where the eggs were laid, making a low broad mound over it, so that one would scarcely guess where the eggs were laid. The whole process took over three hours.

Newly laid eggs were seen from 3 different individuals, varying somewhat in size from turtle to turtle. In the clutch of 92 mentioned above was one tiny egg, the size of a marble.

The sand flats, outside of and especially in the open Tournefortia belt around the Pisonia forest that covers most of the islet, were thickly spotted with the shallow pits, 60 cm to 1 m across, each with a low mound at one side. Two of these mounds were observed to have small holes in them, with numbers of small flies buzzing about them, and, in one case, hermit crabs in the holes. These holes may have been made by the hermit crabs, but were more probably made by young turtles emerging. One hole had a broken shell in it.

On the night of August 6 a few black baby turtles were seen hurrying toward the sea. They were being attacked by large red hermit crabs (Coenobita perlata) and by rats (Rattus exulans). The hermit

crabs bit through the carapace, the rats through the plastron. On August 10 and 11, at about 8 p.m., batches of young turtles hatched out and came running through camp, on their way to the sea. They followed lights.

Almost all of the female turtles that visited Bikar Atoll, well over 300 in the 7 nights, August 5-12, came ashore on Bikar Islet. One set of tracks and a pit were noted on Jaboero Islet, a few on the south part of Almeni Islet, but none on Jaliklik Islet, which is rocky and has no loose sand.

The location of the hole containing the eggs beside the pit excavated by the turtle is in marked contrast with the situation in Malaya and Sarawak, reported by Hendrickson (personal communication), where the hole with the eggs is some distance from the pit.

In 1958 Bikar Atoll and Pokak (Taongi) Atoll, which lies to the north of it, were set aside as preserved natural areas by administrative decree by the then District Administrator, Mr. Maynard Neas. It is hoped that this protection may be strengthened, as clearly Bikar is the principal turtle nesting area in the Marshalls and should be kept as a stocking area for the rest of the archipelago.

PUBLICATIONS

Moreau, R. E., The bird faunas of Africa and its islands. 1-424, Academic Press, London and New York, 1966. $18.00. This is a superb book. Its interest is far broader than its title suggests, and it will hold an audience far wider than the ornithological fraternity. The first three chapters present an excellent, if brief, picture of the geography and ecology of Africa, not just an areal sketch, but soundly based in the time dimension. This makes it possible to consider the entire range of avian biogeography in a convincing ecological context. The fact comes through very clearly that one cannot understand the present distribution of the birds of Africa except against a background of the vegetation, both present and past, as controlled by the factors responsible for the Pleistocene glaciations. Moreau's command of the available information on African birds, on all aspects of their habitat, and on the topographic and climatic history of the continent is impressive. One has the feeling, reading the book, that if existing information can provide the answer to a biogeographic question, the answer is in this book if birds are in any way involved. One can go the whole way in recommending the "mainland" part of the book.

Our readers, however, are interested in islands. Africa is surrounded by islands with every degree of isolation from the continent. Moreau has chosen to limit his remarks to islands reasonably close to the mainland, except for the oceanic Cape Verde group.

The chapter on the faunas of the West Coast islands is disappointing in that it seems a rather standard zoological discussion, with little of the remarkable ecological interpretation that permeates the earlier

Turtles P. 101

Japan current P 21

UNIVERSITY OF UTAH

INSTITUTE OF ENVIRONMENTAL BIOLOGICAL RESEARCH

ECOLOGY AND EPIZOOLOGY RESEARCH

A REVIEW OF THE

ECOLOGY OF ENIWETOK ATOLL, PACIFIC OCEAN

by

ANGUS M. WOODBURY, Ph. D.

This work was accomplished under U. S. Army Chemical Corps Dugway Proving Ground Contract No. DA-42-007-403-CML-427 with the University of Utah.

1962

123pp.

ECOLOGICAL CONSIDERATIONS OF ENIWETOK ATOLL

General features of the ecology of Eniwetok are summarized in an article by Donaldson (1959) which describes the general ecosystem of relationships on two of the atolls that were studied so intensively under the A E C programs. Extracts of this article are given in the following section.

BIKINI AND ENIWETOK ATOLLS

An atoll may be described as a roughly oval, coralline reef rising as high as 15,000 feet above the ocean floor. Within the surrounding reef there is enclosed a shallow lagoon generally with a maximum depth of about 180 feet. The lagoon is open to the ocean by one or more passes cutting through the reef, most of which is awash except at low tides. Emergent land consists of low sandy islets with an elevation usually seven to ten feet above sea level; elevations as high as twenty feet are rare. The islets occupy only a small fraction of the total area of an atoll. Bikini lagoon covers 229 square miles (Handbook on the Trust Territory of the Pacific Islands) and has a dry land area of two and a third square miles divided among some 36 islets; Eniwetok lagoon covers 388 square miles, has a dry land area of two and one-fourth square miles, and forty islets.

The atolls lie in a zone of the northeast trade winds. Because of the constancy in direction of the winds, there are distinct differences in reef form between the windward and leeward sides of the atoll. The windward side is generally considered the region of most rapid growth and is characterized by a narrow, slightly elevated ridge near the reef edge, the Lithothamnion (Lithoporon) ridge, which is lacking on the leeward side. The latter drops off vertically to depths of 100 to 200 feet on the seaward side, while the seaward slope of the windward reef falls away at an angle of about 45 degrees.

On the reef and in the lagoon there is an abundance of colorful plant and animal life in which the keen competition between different species for space and food is very evident. On every hand, there is evidence of rapid growth and simultaneous destruction. Masses of reef-building coral are competing with the coralline marine algae for space, one often overgrowing the other. Schools of green parrotfish gnaw wide scratches on the coral. Fleshy patches of algae are pressed tightly against the surface of the coral and thus hold against the surges of the water pushed across the reef by the crashing breakers. Sea urchins and clams grind niches into the hard coral; some of them constantly feed on the cover of bacterial and algal film which is as constantly being replaced. The clams, the corals, some small fish, and other forms are ceaselessly removing from suspension in the water the small, often microscopic, plants, animals, and bits of debris which make up the plankton. In regions of quieter water, where sand has been deposited, sea cucumbers and spider snails, among the larger forms, turn the sand again and again in their gleaning for food.

Large schools of goatfish, mullet, surgeon-fish, and other plant and plankton feeders are a common sight. Preying on unwary or disabled members of

these schools are the carnivorous fish--the groupers, tuna, jacks and sharks. Ultimately the waste products and carcasses of these and other carnivores are returned to the lagoon and reef to complete the cycle. . . . In the biological cycling of materials there is not only an abundance of organisms but also a wide variety of species--some 700 among the fishes alone (Schultz et al., 1953)--so that whatever is not utilized by one is quickly taken by another. There is here a perfect economy of use of substance essential to life. . . . The phytoplankton comprise the foundation of the food chain in the sea. . . . By their diurnal vertical migration plankton carry . . . materials from the deeper waters of the lagoons to the surface or even up onto the reefs and eventually to the islands. . . . Minerals as well as organic materials, concentrated and incorporated into the algae, are passed on in the food chain to the animals that feed upon them.

The invertebrates, . . . make up the great bulk of the animal life of an atoll. . . . Sea cucumbers have been compared with earthworms in their ceaseless turning of the gravel and sand as they obtain their nutriment from bacteria and algae. Corals and clams remove microorganisms and particulate matter from the water and . . . are eroded by algae and sponges, which bore holes in the skeleton or shell, thus contributing to a return of carbonates to the water. Crabs, sipunculid worms and others also attack the skeleton of the corals. Some of the land crabs . . . drag fish and algae ashore when feeding. In short, within the invertebrates and their symbionts alone complete biological cycles occur from land to sea and back again, from inorganic substances to organic and back again . . . In general, the fishes may be divided by feeding habit into three groups: the herbivores, omnivores and carnivores. . . . The radioisotopes concentrated from the water by the algae are passed on directly to the fish, and from the fish to the animals eating the fish.

Unlike the fishes, the land vertebrates are limited in both kinds and numbers on the islands of the atolls used for the experiments. Two kinds of birds, the fairy or white tern and the common noddy tern and the insular field rat are sufficiently abundant and have adequate distribution to be useful as study material. The terns gather their food from the sea, where they feed mostly upon small pelagic fish, which in turn feed upon plankton. Their wastes represent an "uphill" transfer of minerals from sea to land. . . . Studies of the rats on the islands have shown that this species is essentially herbivorous; they obtain their food from the land plants, seeking out and eating the seeds of grasses, sedges, sandburs, and leaves of some of the succulent plants.

ENIWETOK ATOLL

Eniwetok Atoll in the northwest Marshall Islands is located approximately at latitude 11°30′ N, longitude 162°15′ E, and about 190 miles west of Bikini Atoll, Fig. 5. It consists of about 37 to 40 small low islands atop the coral reefs surrounding a roughly oval lagoon about 20 x 25 miles in size, Fig. 6, flanked by guyots or flat-topped buttresses on the northwest and on the south, about 600 to 800 fathoms below the surface. The small islands occupying only about 2.5 square miles of surface are composed mainly of coral debris piled up at certain places by wave and wind action. Of the three openings that penetrate

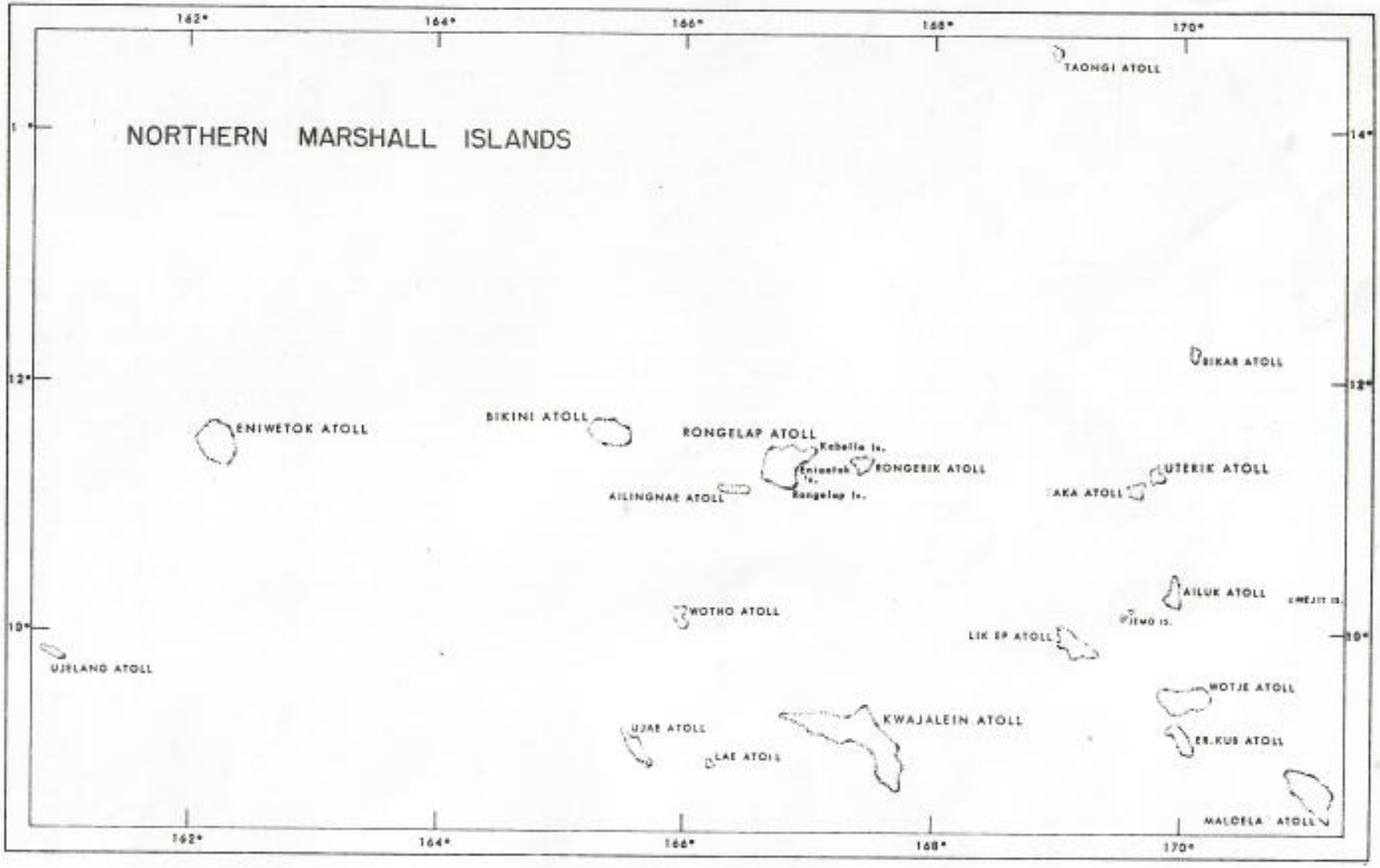


Fig. 5. Map of Northern Marshall Islands.

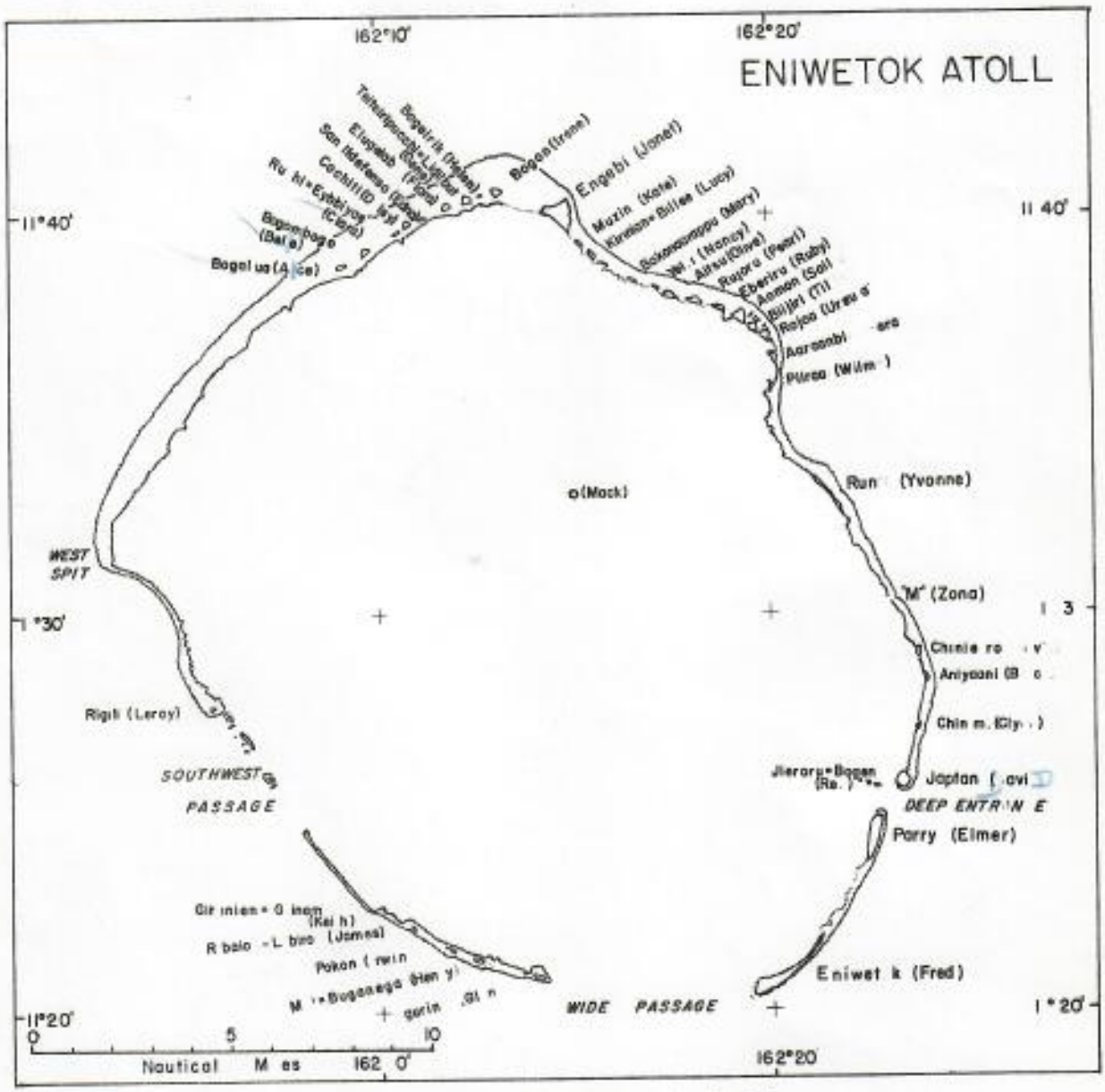


Fig. 6. Map of Eniwetok Atoll.

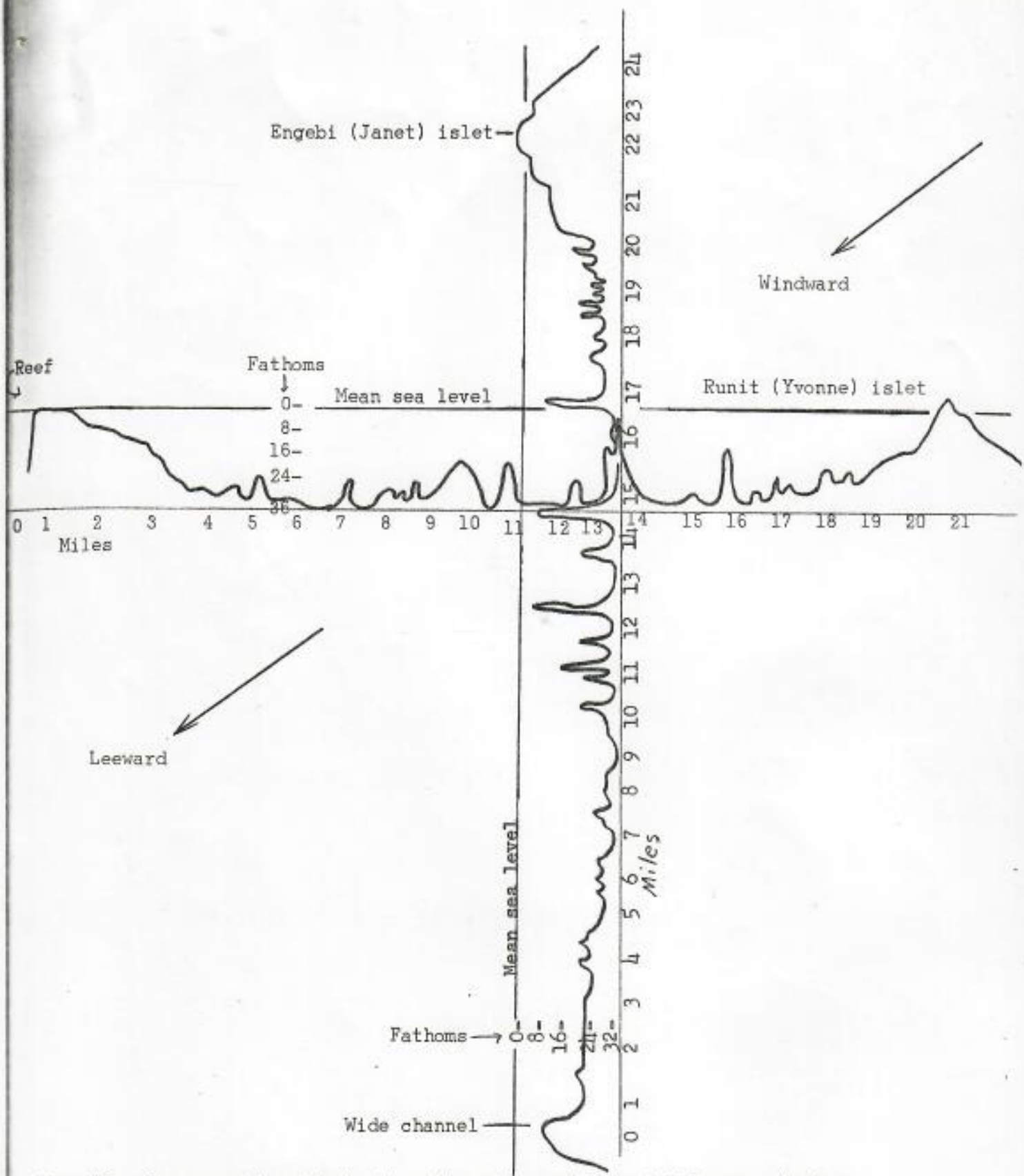


Fig. 6A. Cross and longitudinal sections through Eniwetok Lagoon showing irregularities of the bottom. Redrawn from USGS Prof. Paper 260 Chart 5.

the reef and permit water circulation from the lagoon, one at the southwest, about four miles in width, is only about a fathom in depth; a 6-mile wide channel between Glen and Fred islands at the south ranges from 6 to 12 fathoms, while a one-mile wide passage between Elmer and David has a depth of 31 fathoms (Emery, Tracy and Ladd, 1954:91).

The atoll reef forms a very irregular outline that encloses a more regular oval lagoon. The reef itself may be described as a ridge of coral limest ne roughly, about 20 fathoms in height above the floor of the lagoon, usuall about 1/4 mile in width at the top but thinning out to a few hundred feet in spots and widening to more than a mile in other places. The floor of the lagoo is pitted with depressions several fathoms in depth and dotted with coral knoll or knobs several fathoms in height (ibid).

Geology

Geological explorations, based on two holes drilled on opposite sides of the lagoon, have show that this atoll rests on olivine basalt about 4200 to 4600 feet below the surface. Above this basalt is a thick layer of Tertiary rock composed mainly of limestone with minor quantities of dolomite, dolomitic limestone, silt, and carbonaceous clay. This is surmounted by several hundred feet of soft Quaternary reef limestone. Near the surface, the reefs are in active operation at the present time (Ladd, 1952), Fig. 7.

At the seaward edge of the reef, rich growths of calcareous algae form buttresses against which the sea waves beat, Fig 8, and overflow or push inward through surge channels between them. This series of high points, known as the Porolithon (Lithothamnion) Ridge, (Thomas, 1961:12) usually slopes gently out to sea until it drops off into deep water. Inside this ridge, pavement forming algae form thickened ridges along the sides of the surge channels and farther back these channels become roofed over and form an extensive rough irregular honey-combed surface kept wet by the overflowing water from the beating waves. The incessant pounding of the waves produces a good deal of erosion on parts of the reef that break under the heavy wave bombardment (Emery, Tracey and Ladd, 1954:92).

Islands

The islands of Eniwetok atoll piled on top of the reef vary in size from mere piles of coral debris, piled by the currents and waves or blown by the wind, through practically all stages of accumulation to well established land covered with vegetation. Many of the vegetated islands have enough plant litter mixed with the coral sand to form a layer of soil, anchored by plant roots and protected from wind and sunshine by plant cover.

The islands occur in a roughly oval pattern on the north, east and south sides. They do not occur on the central part of the west side where prevailing winds, currents and waves from the lagoon do less erosional work. Authorities do not agree on the exact number of islands in the atoll ring, but at least 45

have been considered of sufficient importance to give alphabetical names. On the map, Fig. 6, two sets of names are given--the old names and the new Army names arranged in alphabetical order, beginning at the northwest and proceeding in clockwise direction with girls names from Alice to Zona and with boys names from Alvin to Leroy, ending at the southwest, but extending irregularly to Van on smaller islets on the reef and on coral knolls in the Lagoon.

Lagoon

The lagoon, plotted from 180,000 soundings taken from recording echo sounder tapes, shows a remarkably irregular topography due largely to the abundance of coral knolls. The contour map shows a coral wall about 20 fathoms in height, sloping inward, down over a terrace between the 12 and 20 fathom contours. Beyond this is the floor with a much more gradual slope out to the deepest part of the lagoon which is located slightly north and west of the center. This bottom is exceedingly irregular being dotted with numerous coral knolls, a dozen or two of which reach nearly to the surface and a few actually penetrate the surface waters, especially at low tide.

The main basin in the lagoon forms a nearly perfect ellipse within the 20 fathom contour. Much of the bottom is more than 24 fathoms in depth. About half of this area is over 28 and deepens to a maximum of about 35 fathoms.

The coral knolls in the bottom of the lagoon occupy about 13 per cent of the area. Otherwise, the floor is covered mainly by three types of deposit: 1) beach sands occupying a narrow ring inside the lagoon reef, are being continually washed, broken and work by the waves and the finer materials washed out further into the lagoon, mainly two to four, occasionally as much as five miles. They cover about 52 per cent of the lagoon floor. Inside this belt of sand and fine debris is 2) a zone that covers about 26 per cent of the floor, in which Halimeda grows well and leaves its tests on the bottom. In the deepest part of the lagoon, below 32 fathoms, where the Halimeda does not thrive, 3) foraminifera with their remains become dominant and cover about 9 per cent of the floor (Emery, Tracey and Ladd, 1954:99).

Climate

The Marshall Islands, a few degrees north of the equator, lie in the path of the northern trade winds during much of the year, especially during the northern winter but as the equatorial calms move northward in summer, the southern part of the group is exposed to some of the calms, counter winds and counter currents. The islands lying across the path of the latter, provide considerable interference so that the major influence of winds and waves comes from the east and northeast. From December to March these winds are relatively constant at the rate of about 18 knots per hour but are lighter and more variable during the rest of the year. There is often considerable difference between the windward and leeward sides of individual islands and often differences in islets in similar positions of different lagoons. The precipitation is relatively low, the annual average ranging in the neighborhood of 40 inches in the north to 96 in the south but is not evenly

distributed seasonally and occasional drouths are not unknown (Emery, Tracey and Ladd, 1954:18).

The climate of the northern Marshalls is essentially of a tropical marine type, almost uncomplicated by physiographic factors. Temperatures usually range between 68 and 95 degree extremes, but ordinarily range between 80 and 90 degrees F. (Fosberg, et al., 1956:7-8).

From the work of Robinson (1954:281-291), the sea temperatures around Eniwetok at the surface and at 400-foot depths have been plotted in Fig. 9. From this graph, it is obvious that surface temperatures have a very narrow annual range in variation, approximately 4° F. from 81° to 85° and an annual average of above 83° F. Since air temperatures tend to approximate sea temperatures in marine climates, it is expected that the weather temperatures of the low atoll islands at Eniwetok will generally range in the seventies and eighties, except in the densely vegetated areas where the tropical sunshine heat may be trapped by the vegetation and the temperatures may go considerably higher.

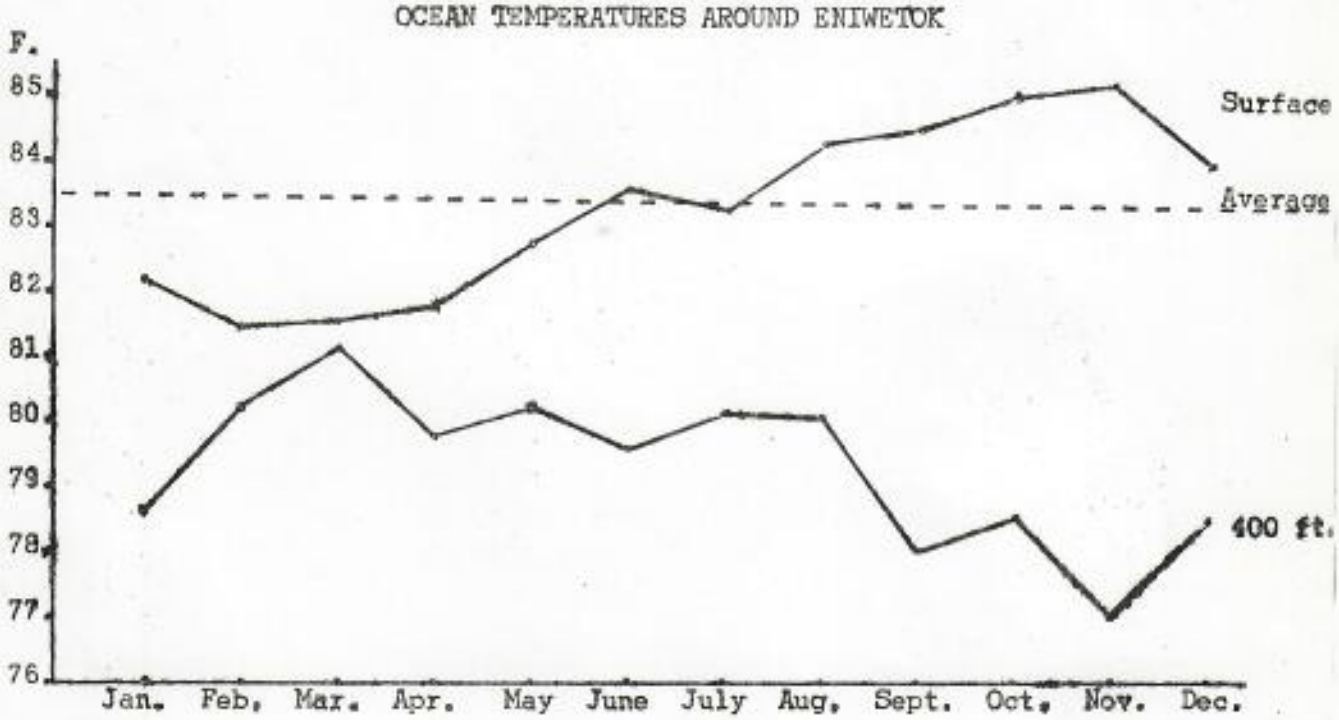


Fig. 9. Sea temperature around Eniwetok plotted from USGS Prof. Paper 260-D.

Soils

In general, soils on the coral islands of the northern Marshalls, are derived from the parental material or coral sands. These sands are composed almost entirely of calcium deposits and shells precipitated from sea water by algae, coral polyps, or other calcium-extracting organisms with little, if any, silicon deposited by Foraminifera or other silicon

extracters. The basal layers of these sands of the islets are essentially like the loose sands now accumulating on the reefs and around parts of the islets. These are usually so coarse that water readily drains through the particles.

The soils have been initiated on such sands mainly by the action of pioneer plants that have been able to establish themselves in such a harsh environment, bind the sand with roots and cover it with litter. These pioneers usually include among the native vegetation, such plants as sedges, grasses, Scaevola bushes and Messerschmidia shrubs or trees. As the litter on the surface and roots of dead plants disintegrate and mix with the sand, they increase the water-holding capacity and slow the seepage of rainwater downward through the sand.

As this slow process gradually increases the organic content and moisture-holding capacity of the sand, the upper layers assume a darker color and form an A horizon containing humus. As this layer thickens and deepens, it may reach the stage of subdivision into layers of A_0 containing decomposing litter, A_1 containing mainly humus, A_2 a mixture of sand and humus, and A_3 mainly sand colored with humus. Below this, the sand is usually classified as horizon C, sometimes of different subtypes. Examples have been found which show alternate dark and light layers indicating a soil development followed by a covering of sand and a new soil development above it (Kenady, 1962).

As the organic content increases, the pH is gradually modified. From a high, usually in the neighborhood of 8.9 to 9.2 in the sand, it gradually lowers toward 8.0 at the surface of the soil under the litter. There is also a greater concentration of magnesium, sodium, and potassium in the surface layer of soil as the organic content increases and these usually decline at greater depths in the soil where there is less organic matter (Kenady, 1962). Locally, some soils are strongly phosphatized, probably from former guano deposits associated with bird roosting or nesting sites (Fosberg, et al., 1956:20).

Accumulation of an A horizon in the soil heralds the development of 1) a greater water holding capacity that slows the drainage of rainwater and holds it for longer periods of time, and 2) the introduction of new plants if seeds are available--successors to the pioneers. This leads to greater variety of vegetation.

Fresh groundwater exists in limited quantities in nearly all of the vegetated islets and islands. Where porosity in the soil or rock regulates downward drainage at a suitable rate, fresh water may accumulate in lens shaped bodies resting on sea water with the thin edge of the lens approaching the edge of the island approximately at mean sea level. The high point of the lens will stand about one unit above to 40 units below sea level. If downward seepage of fresh water offsets the diffusion (mixing) with sea water, the lens will remain fresh and potable; otherwise it will become brackish if the mixing proceeds faster than the supply of fresh water offsets it. This supplies plants that require fresh water and may be tapped for human use under favorable conditions. It may be depleted or brackish during prolonged drouth (Fosberg, et al. 1956:149-150)

Vegetation

The vegetation on the Eniwetok Islands is very similar to that of many other low coral islands of Micronesia. Merrill (1945:207) states "Botanically, the low islands are very uninteresting and monotonous. The flora of one is usually quite the same as that of another. . . . The native vegetation may be scanty or reasonably well developed depending on the size of the island, the quality of its soil, and whether or not it is permanently inhabited." Certainly the Eniwetok Islands show a great diversity in development of vegetation on them, ranging from mere piles of coral debris with no vegetation through stages of grasses and sedges, shrubby scaevola, and small trees to dense forests, some of which contain tall palms formerly under cultivation.

Historical Resumé

According to St. John (1960:313) the Marshall Islands were discovered in 1817 on the Rurik voyage of the German captain Otto von Kotzebue. Although extensive plant collections were made in the Marshall Islands, Eniwetok itself was not visited. There are no known accounts of the flora in Eniwetok during the successive occupations of Micronesia by the Spanish and the Germans, but with the Japanese occupation wide explorations throughout Micronesia were made. The first collections of plants from Eniwetok atoll were made in August 1934. These included several species of Pandanua which were studied and reported by R. Kanehira and are preserved in the herbarium at Fukuoka, Japan.

During the American conquest in February, 1944, the heavy bombardment and fighting on Eniwetok (Fred) caused general devastation on this islet and probably on several others. During the occupation of Eniwetok by the American military forces, Major Edwin H. Bryan, Jr. collected additional plant specimens and gave the first general summary of the flora of Eniwetok. The specimens are now in the Bernice P. Bishop Museum, Honolulu.

Nearly two years later in mid-May 1946, large botanical collections were made by F. Raymond Fosberg and Edward Y. Hosaka. They were associated with the U. S. Commercial Co's Economic Survey of Micronesia, and the collections are preserved in the Bishop Museum and in the U. S. National Herbarium, Washington, D. C.

In association with the broad scientific studies of the American Atomic Bomb Testing Program in 1946, William Randolph Taylor made botanical collections of several of the islets of Eniwetok. The specimens are distributed between the U. S. National Herbarium, the University of Michigan Museum and the Bishop Museum. They are reported by Taylor (1950). During August, 1949, Harold St. John, associated with the Donaldson Expedition for the AEC, made numerous botanical collections which are now housed in the Bishop Museum, the Smithsonian Institution, Washington, D. C., and the University of Washington at Seattle.

On August 1, 1956, S. C. Rainey collected plants from Rigili (LeRoy). His specimens were identified by F. R. Fosberg in Washington, D. C. The

specimens collected by Irwin E. Lane on several of the Eniwetok Islets in August and September 1957 are preserved at the Bishop Museum. Specimens collected by Harold St. John on several of the southern islets of the atoll in early August, 1958, are preserved at the Marine Biological Laboratory at Eniwetok (Fred) and in the Bishop Museum.

Ecological Background

Eniwetok is in the northern and drier section of the Marshall Islands. Because of the dryness and the small mostly narrow islets, there is little diversity in the habitats. There are no large sand dunes, fresh water ponds, or central hollows with rich black humus top soil, except a small pool on Japtan (David) islet and a small explosion crater on Belle. The principal physical habitats are: 1) outer beaches of coral rock or coral gravel, 2) inner-beaches of coral sand, 3) small coral sand dunes, 4) coral gravel flats, and 5) coral sand flats. The higher parts of these are usually covered with vegetation. The islets do not have dense lush damp forests nor is the total flora large. Some of the plants seem restricted to a particular habitat, but the zones formed are rather indefinite. Their occurrence seems governed, not so much by the soil as by 1) the size of the islet, 2) the distance from the sea in terms of shelter from salt spray, and 3) the availability of fresh water in the water table. The flora given by St. John (1960:314) is summarized as follows:

42	species of indigenous plants
27	species of adventive weeds
26	species of food and ornamental plants
95	total

Of these, seven species are known only from seeds or fruits found in the jetsam on the sea and the lagoon beaches. Of these seven, Hernandia sonora is native to other islands of the Marshall group; Caesalpinia bonduc and Aleurites moluccana are of wide occurrence and could have come from the northeast, south or west; Mucuna urens and Sapindus saponaria must have come from the northeast being abundant in Hawaii and absent in other parts of the tropical Pacific; Dioclea reflexa and Entada phaseoloides must have come from the south or west. St. John concludes that of the six drift species not found in the Marshall Islands, four surely floated from Hawaii on the Japan current which regularly flows past Hawaii towards the Marshalls and the Central Pacific. The other two species of southern or western origin may have traveled eastward on the equatorial counter current and have been wafted northward during a southerly storm.

Ecological Succession

It is well known that many of the low coral islands on reefs show stages of development from mere piles of coral sand through successive stages of accumulation to well developed loamy soils bearing heavy forest stands. Examples could be selected that would illustrate the steps in succession through which

the advanced islands probably passed to reach their present stage of development. Palumbo (1962) watched the recovery of plants on Belle Island of the Eniwetok Atoll after a nuclear explosion denuded the island and produced a secondary bare area. Later studies have been made of the distribution of vegetation on the islets by the crew from the University of Utah in the spring of 1962.

This pattern of recovery on Belle showed quite a different pattern from that expected from a primary bare area which with the assistance of Palumbo, Held, Bushman and others, I have charted approximately as follows: When coral sands are piled sufficiently large and high to hold fresh rain water, Scaevola frutescens and/or Messerschmidia argentea seeds from neighboring sources germinate and become established. Seeds may be carried by water or by birds, occasionally by wind or by man (Fosberg, et al. 1956:216). Their roots in the fresh water begin to bind the soil, the crowns shade the ground and reduce soil temperature, and the litter incorporated in the soil improves the organic content and helps to hold more moisture. The presence of plants helps to slow winds carrying sand or sediment and thus increases the size of the island. On some islands, the waves wear at one side while winds transport sand to the other side, Fig. 10, thus producing a slow migration of the island.

After Scaevola or Messerschmidia have pioneered the first harsh environment (excessive salinity, strong sunlight, high temperature, scarce nutrients), a grass, such as Lepturus repens, and a sedge of the genus Fimbrystilus join these hardy pioneers and help in further ameliorating the environment, Figs. 11 and 12. These are assisted by other sand binders, Suriana maritima, and the creeping morning glory, Ipomea tuba, Figs. 13 and 14. Once established, this morning glory may extend its long runners over fresh sand surfaces and act as a sand binder that will hold the sand in place while other vegetation becomes established. In this way, it acts as a pioneer. The accident of dispersal may change this sequence in different ways and lead through different routes to a heavy cover of vegetation.

With the advent of vegetative cover, some of the fish-eating birds, especially the terns, begin to use the vegetation for nesting purposes, some on the ground among the herbage or shrubs, others in the trees. Wherever they nest, the consequent guano brings much needed minerals from the sea, especially phosphorus, that adds to the fertility of the soil. These extra minerals incorporated into the plants, thence into the plant litter and again into the soil pave the way for the entry of additional plants that could not survive well as pioneers.

When the cover is adequate to provide a more hospitable environment (reduced salinity, shaded soil, lower temperature, and better nutrition), certain secondary plants enter the vegetation, particularly the prostrate vines, Triumfetta procumbens and Boerhaavia tetrandra and the dodder-like parasite, Cassytha filiformis, Fig. 15. Other species characteristic of later stages of the vegetation may be added as conditions become more favorable and their needs become available. These include woody trees that can become established in thick vegetation and push their way into dominant positions. In the thick wooded interior of the islets of the Eniwetok Atoll, woody trees of Morinda, Pisonia, Cordia, Guettarda and the coconut, Cocos nucifera are common, while Pandanus, Terminalia, Tournefortia, and others occasionally occur. Views of heavy stands typical of the wooded islets are shown in Figs. 16 and 17. On David (Japtan) islet, a small slightly

brackish pond occurs on the southeast one third of the island in a heavy stand of brushy vegetation, mainly Messerschmidia and Pisonia, such as shown in Fig. 16. Views of fruit of Scaevola are shown in Fig. 17 and flowers and fruit of Messerschmidia in Fig. 18. A view of a coconut palm grove on Japtan (David) islet is shown in Fig. 19 and a sprouting coconut among morning glory vines is shown in Fig. 20. An exotic driftwood log brought by ocean currents from distant lands is shown in Fig. 21. It is identified as a Tahitian chestnut.

On Belle (Bogombogo) islet that was cleared of surface vegetation by a nuclear explosion, Palumbo (1962) found in general, that most of the shrub vegetation produced new growth from subterranean parts or from stem stubs left standing after the foliage and limbs had been torn away by the blast. Such plants rapidly re-vegetated on that islet where the soil was left intact, but on Daisy (Cochiti) islet that lost most of its soil, pioneering had to begin from a primary bare area. The difference is shown in Fig. 22.

The pattern of vegetational change in advanced stages of development is not well understood and but few if any of the heavy stands at Eniwetok have reached a stage that can be called mature in which a reasonable degree of stability has been attained in the direction of a dynamic equilibrium with the environment. This may be interpreted to mean that further natural changes are likely to occur in the stands of vegetation. In a native forest of Eniwetok, introductions of new species may lead to further change.

In such atoll native forests, vegetation holds the key to its own perpetuation. Nearly all of the fertility for plant growth is stored in the vegetation itself, its litter on the ground, and the dark colored top few inches of soil. When the organic matter in the soil is decomposed, the forest vegetation gathers plant nutrients as they become available and slows loss through leaching. Clearing of the forest cover and cultivation upsets this cycle and allows greater leaching losses, thus depleting fertility.

Cover of the islets

The vegetation on the islets shows variation ranging through all of the succesional stages of development. There are many bare sand spits that are covered and uncovered by the tide; others project above the highest tides. Permanently exposed above the water are many small points bearing small stands of Scaevola and Messerschmidia plants. Larger islets are usually covered with other types. From observations, photographs, and field notes of John Bushman and other members of the field expedition, the following ecological descriptions have been obtained.

see p 14 MAP

Alice

A small islet, about 1/4 x 1/8 miles, with cover of scaevola and messerschmidia shrubs, from 2 to 8 feet in height, denser and taller on the west side, interspersed with patches of heavy grass, all of which has regrown since it was

devastated by nuclear detonation, Fig. 22. Stumps indicate that the islet formerly supported large coconut palms.

Belle

This small islet, slightly larger than Alice, has a denser cover of the same shrub types but taller (1 to 9 feet), and an occasional large-leaf Guettarda occurs, Fig. 22. Much of the scaevola is infested with the parasitic dodder, Fig. 15.

Clara

This islet, smaller than Alice is covered with a sparse stand of scaevola and messerschmidia shrubs, 4 to 8 feet tall, interspersed over two thirds of the island with coconut palm stumps and hummocks of dry grass, Fig. 22.

Daisy

This islet, much larger than the three preceding islets, was denuded of its vegetation and most of its soil by a nuclear detonation and now has a scattered stand of young messerschmidia shrubs, mostly concentrated along the lagoon edge where the plants are more vigorous and taller, Fig. 22.

Edna

This islet, also badly battered by a nuclear detonation, has no vegetation except a few small messerschmidia plants about 6 to 24 inches high. It is now mainly a narrow spit or sand dune.

Helen

This is a small islet with a causeway connecting it to the larger island, Irene. What is left after a nuclear detonation is an elongated spit or sandbar containing little vegetation, mainly small messerschmidia plants from a few inches to three feet tall.

Irene

This medium sized islet is ringed with a hedgelike row of shrubs, mainly messerschmidia. The interior is more open with shrubs and trees widely spaced among a grass-sedge covering, Fig. 23.

Janet

This, the largest islet in the north end of the atoll, has dense growths of messerschmidia up to 12 feet tall on the lagoon side and much sparser shrubs including clumps of scaevola on other parts of the island, Fig. 24. On the north end, the openings are filled with hummocks of dry grass, Fig. 25. In other openings, vines of morning glory, Ipomoea and Triumfetta, crisscross the landscape, similar to that shown in Fig. 14.

Kate

This small islet with much loose sand on it, has a covering of low shrubs, mainly scaevola, 6 to 8 feet tall, with scattering messerschmidia, Fig. 26.

Lucy

Another small islet with a stand of scaevola 6 to 10 feet tall, spotted with messerschmidia and guettarda. There was little, if any, grass to stabilize the loose dry sand scattered among the vegetation.

Mary

Similar in size to Kate and Lucy, this islet has two large and one small coconut palms growing among the sparse scaevola and messerschmidia shrubs, intermixed with grasses and vines on the loose sand among the brushes, Fig. 27.

Nancy

This small islet has a dense stand of shrubs 8 to 12 feet tall, mainly scaevola with scattering messerschmidia and guettarda interspersed and about 10 to 15 short coconut palms about 10 to 12 feet tall. No grass was observed.

Olive

This pear-shaped islet, Fig. 28, about 3/8 miles in length, has a mixed cover of scaevola and messerschmidia, 5 to 10, occasionally 15 feet tall, the site of great nesting colonies of birds. On the west (lagoon) side, plants are fairly dense with little vegetation under them but on the east side, the stand is more open with interspersed vines a foot or two in depth. At the stem end of the pear, dry hummocks of grass are interspersed among the bushes.

Pearl

This islet, larger than Olive, is ringed with a lush stand of scaevola, to 14 feet tall, and messerschmidia, 10 to 12 feet. The more open interior s a grass sedge cover interspersed among the shrubs.

Ruby, Sally, Tilda, and Ursula

These four interconnected islets are sparsely covered with re-growth getation since the nuclear detonation of 1958 that seared nearly all of the ants. The coconut palms did not recover but the scaevola and messerschmidia rubs are now 10 to 15 feet tall. Grass hummocks occur in open spaces of the terior of the islets. Ursula is shown in Fig. 29.

Vera

This small islet bears a dense stand of the usual shrubs, grasses and vines terspersed with scattering palms in the interior, Fig. 30.

Wilma

This small islet has the usual scaevola and messerschmidia shrubs with tches of grasses and suriana vines.

Yvonne

This is a dry sparsely vegetated islet, mainly hummocks of grass, with casional plants of scaevola and messerschmidia, Fig. 31.

Sam, Tom, Uriah, and Van

Sam is a sand spit only. Tom is very small containing sparse messer- midia trees up to 18 feet tall. Uriah and Van are larger and well vegetated h scaevola shrubs up to 10 or 12 feet in height and messerschmidia trees up 15 feet.

Bruce

The southern end of this islet bears a heavy stand of scaevola, Fig. 32. ther north, coconut palms overtop a dense forest, 30 to 40 feet in height, taining Pisonia and Cordia trees with a mixture of messerschmidia and scaevola to 15 or 20 feet. In places, Boerhaavia forms an understory and the morning ry vines grow in openings of the forest, Fig. 20.

Clyde

This small islet is covered with scaevola about six feet tall and messerschmidia about eight feet, interspersed with a grass mat under and between most of the shrubs.

Rex

A long sandy spit from the west gradually yields to higher lands covered with grass and the usual scaevola and messerschmidia shrubs up to 15 feet tall and the less common pisonia, 35 to 40 feet, two guettarda trees and some triumfetta vines with the high point at the east end about 12 or 15 feet above the water line.

David Japtan

Much of this island has been disturbed by human use. On the undisturbed portions, there are many palms, pisonia, messerschmidia, and scaevola trees and shrubs and has a rich avifauna.

Medren Enewetak

Elmer and Fred

Both of these islands have heavy human use and there is little natural vegetation left on them.

Glenn Ejuvin

This island has been restricted from recent human use and shows the natural vegetation with little human disturbance, Fig. 33. There is a dense jungle forest on the eastern part of the island giving way on the west to lower more open trees, shrubs and grasses. The prominent forms of the jungle are palms, pisonia and messerschmidia trees. The latter reaches heights of 30 to 40 feet with trunks 6 to 10 inches in diameter. Prostrate vines are common in the jungle. Scattering miranda and guettarda trees are associated with the ubiquitous scaevola shrubs.

Henry

Heavy vegetation on parts of this islets are ringed with dense scaevola between the beach and the palms, Fig. 34, but on other parts there are open spaces, Fig. 35.

Irwin

This islet is cut by a waterway and has more or less typical vegetation, Fig. 36.

James

No notes available.

Keith

This teardrop-shaped islet has the narrow end at the southeast dominated by scaevola which yields in the wider portion to a taller forest of coconut palms with an understory of messerschmidia trees, associated with a long strip of pisonia trees, 30 to 45 feet tall and scattering pandanus trees. The soil is loose and there is little grass.

Leroy

This islet showing much human activity is pitted with several large dry craters. Scaevola occurs generally around the edge of the island but also inland where it is generally dominated by messerschmidia, pisonia and palm trees. There are scattered morinda and guettarda trees among them; also considerable grass and triumfetta and morning glory vines.

The Fauna

The fauna of Eniwetok Atoll contains a sparse assortment of terrestrial and quasi-marine species. From a review of literature and judged from neighboring atolls, invertebrates include worms, mollusks, an assortment of nocturnal crabs, several species of centipeds, scorpions and spiders, and insects of considerable variety, including cockroaches, scale insects, termites, fruit beetles, fruit flies, ants and other kinds (Fosberg, et al. 1956:221-238). The vertebrates probably consist of a single species of native mammal (The Polynesian rat), about 25 or more species of birds, five or six lizards, and two turtles. Studies of a civilian crew from the University of Utah in the spring of 1962 have corroborated the presence of 22 species of birds.

Invertebrates

The invertebrates of Eniwetok Atoll include a much more heterogeneous assortment of kinds than the vertebrates. Both ecto and endoparasites doubtless came with their host vertebrates but other kinds must have arrived independently. Winged insects and small spiders sailing on silken webs blown by the wind might have come through the air. Other small invertebrates may have arrived on the feet of birds, on flotsam of ocean currents, on winds of tornadoes or as stowaways with human cargoes. Still others wander onto the land from their home in the sea. The presence of others is difficult to explain.